THE CANADIAN WATERFOWL MAIL SURVEYS – DESIGN, RESULTS AND THEIR RELIABILITY

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INTRODUCTION

A major need in waterfowl management in Canada has been improved data on the annual harvest. Although several provinces have obtained information on the waterfowl harvest, their results are not comparable and in most cases the surveys undertaken were not based on the principle of random sampling, so that the reliability of the estimates is not known. Accordingly, in 1967 the Canadian Wildlife Service initiated a national survey (Benson, 1967) of waterfowl to obtain more information on the number of birds killed and when and where they were taken by waterfowl hunters.

This paper deals with the design of the survey and provides expressions for estimating some of the population parameters and their errors consistent with the design of the survey. It turns out that the basic sampling problem is similar to that of surveys where estimates are required for domains of study which cut across the strata which has been studied by Cochran (1963) and Durbin (1958). In such situations the estimates such as average kill per hunter are based on fewer individuals than the number of hunters selected in the sample since some of the hunters may not have hunted. Besides, valid estimates of total kill cannot be obtained as a simple expansion of the mean (kill per hunter) since the total number of hunters in the population who have participated in hunting will not be known. Theory, based on conditional probability, is developed here for obtaining unbiased estimates of the population means and totals and has been applied to the data from the Canadian waterfowl harvest surveys for 1967-68 and 1968-69 to provide estimates of the means and totals of some of the important characteristics and their errors. Of the species, sport ducks, geese, sea-ducks and coots, comprising waterfowl, the last two have been omitted from the study where estimates are required by species since our studies reevaled high coefficient of variation and hence low reliability of the characteristics for the latter species for a large majority of the provinces.

2. Object

The main objectives of the survey are to provide reasonably reliable estimates at the provincial and national levels of :

(*i*) Number of active hunters (who hunted one or more days) ;

(*ii*) Number of successful hunters (who shot one or more birds) ;

(*iii*) Number of birds of a given species shot and retrieved by a successful hunter ;

(*iv*) Total number of birds of a given species shot and retrieved ;

(*v*) Average number of days hunted per person ;

(*vi*) Total number of man-days hunted ; and

their errors based on survey data for 1967-68 and 1968-69. Estimates for the last two items were obtained for successful and active hunters (who hunted one or more days).

3. Design of the Surveys

The sampling universe for the Canadian waterfowl harvest survey intiated in 1967 consisted of persons who bought Canada migratory game bird hunting permits sold during the 1966-67 season at post offices all over the country, Benson (1967). Purchase of the Canada migratory game bird hunting permit was required of all migratory game bird hunters in Canada. The permit contains information on name, age, address, sex, etc. to be filled in by the post office where the permit is sold.

A stratified random sample with provinces as strata and previous year's permit holders as ultimate units of sampling was selected for the survey. In practice, a systematic random sample of permit holders was selected in each province from the sales records after sorting by permit number on the computer. Unusable addresses, where identifiable by the computer, were replaced.

A ten per cent sample was aimed at for the whole of Canada. The allocation of the total sample of the provinces was based on the size of the provincial universe and estimates of variability of the season bag of the ducks obtained from earlier surveys. Immediately preceding the hunting season, a hunter who purchased a permit during the preceding year was mailed an abstract of the regulations for the current year for the province in which he bought his 1966 permit. Members in the sample were informed of the objectives of the survey and that they would receive a questionnaire at the end of the season ; they were provided with a *contact* card to record their kill of waterfowl and to facilitate completion of the questionnaire. Persons failing to return the first questionnaire within three weeks were mailed a follow-up questionnaire. Replies to questionnaires were scrutinised and the data were then transferred to magnetic tape.

4. Response

The 1967-68 and 1968-69 sample survey data on waterfowl mail surveys based respectively on 14,697 and 12,951 usable responses (Table 1) were employed in the study. The unusable responses consisted of spoiled, blank or incorrect returns, envelopes returned by post offices as *undeliverables* and returns from hunters (selected from the previous year's permit holders) who did not buy permits during the current season. The non-Canadians and Canadian females who formed a relatively small percentage of the total have been omitted from the study. The observed data were the results of kill of ducks (excluding sea-ducks) reported by individual hunters in the sample. The reduction in sample size during a year from that mailed is because the latter were selected from hunters who purchased permits during the previous year but did not necessarily do so during the current year.

It will be seen that the reponse rate of hunters who bought permits during 1967-68 or 1968-69 were 49 and 50 per cent, respectively, for Canada as a whole ; the response rates for active hunters (who bought permits and also hunted) were, however, 41 and 40 per cent, respectively.

In view of the high non-response, studies have been undertaken by sending a second follow-up to those who fail to respond to the first follow-up within a month from the mailing date. Pilot investigations are also underway by selecting samples stratified over the season

5. Theory

and from the current year's permit holders (who did not buy permits during the previous season) as the same are received at headquarters.

It is proposed to present in this section estimates of the population characteristics outlined in the objectives. Suppose there are L strata (*e.g.*, provinces) containing $N_{01},\ldots\ldots N_{oh},\ldots\ldots N_{oL},$ and $N_1,\ldots\ldots N_h,\ldots\ldots N_L$ permit holders in 1966 and 1967 respectively. Sample of $n_{01},\ldots\ldots n_{oh},\ldots\ldots n_{ol},$ permit holders are selected from the 1966 list ; of these $n_1,\ldots\ldots n_h\ldots\ldots n_l$ are those who bought permits during 1967.

Let $N_1',\ldots,\ldots N_h',\ldots\ldots N_L'$, and $N_1''\ldots\ldots N_h'',\ldots\ldots N_L''$ be the number of active and successful hunters during 1967 respectively, $n_h',\ldots\ldots n_l'$ replace and $n_1''\ldots\ldots n''_h,\ldots\ldots n_l''$ the corresponding number in the sample ; also let $n_1^o,\ldots\ldots n_l^o$ be the number of permit holders in the sample during 1967 who did not hunt $(n_h=n_h'+n_h^o)$. Further, let Y'_{ih}, Y'_{ih} denote the number of waterfowl shot by the i^{th} hunter in the population and the sample respectively and D_{ih}', d_{ih}' the corresponding number of days hunted during the season by the i^{th} active hunter.

5.1. *Estimates of Totals*

An unbiased estimate of the number of active hunters N'_h for the h^{th} province is given by

$$\hat{N}'_h=\frac{n_h'}{n_h}N_h \qquad \ldots(1)$$

where both n_h and n_h' vary from sample to sample.

Proof : The conditional distribution of $\frac{n_h'}{n_h}$ for a fixed n_h is an ordinary hyper-geometric

$$P_r\left(n_h' \mid N_h, N_h', n_h\right)=\binom{N_h'}{n_h'}\binom{N_h-N_h'}{n_h-n_h'}\bigg/\binom{N_h}{n_h}$$

Hence

$$E\left(N_h\frac{n_h'}{n_h}\right)=E_1\,E_2\left(N_h\frac{n_h'}{n_h}\right)=N_h'$$

where the operator E_2 stand for the conditional expectation for fixed n_h and E_1 is the operator after E_2 has been taken when n_h' varies.

Similarly, an unbiased estimate of the number of successful hunters in the h^{th} province is given by

$$\hat{N}_h''=\frac{n_h''}{n_h}N_h \qquad \ldots(2)$$

An unbiased estimate of the number of waterfowl shot and retrieved (Y_h') in the h^{th} province will be given by

$$\hat{Y}_h'=N_h'\bar{y}_h'=\frac{N_h}{n_h}y_h' \qquad \ldots(3)$$

where

$$y_h'=\sum^{n_h'}y_{ih}'$$

The proof follows if we first consider the conditional expectation of (3) for a given n_h' and n_h and then take the expectation of the result thus obtained by letting n_h' vary from sample to sample.

Similarly, an unbiased estimate of the total number of man-days of recreation D_h' is given by

$$\hat{D}_h'=\frac{N_h}{n_h}\,d_h' \qquad \ldots(4)$$

where d_h' denotes summation of d'_{ih} over the sample of active hunters n_h'.

The estimates presented in (1), (2), (3) and (4) can be summed over the provinces to provide estimates at the national level.

5.2. Estimates of Means

An unbiased estimate of the number of waterfowl shot and retrieved per hunter ($\bar{Y}'_h$) during the season is given by

$$\bar{y}_h' = \sum^{n_h'} \frac{y_{ih}}{n_h'} = \frac{y_h'}{n_h'} \qquad \ldots (5)$$

where y_h' stands for $\sum^{n_h'} y_{ih}$

Proof : $E_1 \, E_2 \left\{ \frac{\sum^{n_h'} y_{ih}}{n_h'} \,\middle|\, n_h' \right\} = E_1 \, (\bar{Y}_h') = \bar{Y}_h'$

where the operator E_2 stands for conditional expectation for fixed n_h' and E_1 is the operator after E_2 has been taken when n_h' varies.

Hence $\bar{y}_h'$ is an unbiased estimate of $\bar{Y}_h'$.

Similarly, an unbiased estimate of the average number of days hunted per hunter ($\bar{D}_h'$) is given by

$$\bar{d}_h' = \frac{\sum^{n_h'} d_h'}{n_h'} \qquad \ldots (6)$$

The estimates of the means corresponding to (5) and (6) at the national level will be given by

$$\hat{\bar{Y}}' = \frac{\sum^{L} \hat{Y}_h'}{\sum^{L} \hat{N}_h'}$$

and

$$\hat{D}' = \frac{\sum_{h}^{L} \hat{D}_h'}{\sum \hat{N}_n'}$$

5.3. Variance of the Estimate Mears and Totals

Theorm : An unbiased estimate of $V(\bar{y}_h')$ is given by

$$\left(1 - \frac{n_h'}{N'_h}\right) \frac{s^2_{y_h'}}{n_h'} \quad \ldots (7)$$

Proof :

$$E\left[\left(1 - \frac{n_h'}{N_h}\right) \frac{s^2_{y_h'}}{n_h'}\right]$$

$$= EE_2\left[\left(1 - \frac{n_h'}{N_h'}\right) \frac{s^2_{y_h'}}{n_h'} \middle| n_h'\right]$$

where

E_2 is the expectation for a given n_h'

$$= E\left(\frac{1}{n_h'} - \frac{1}{N_h'}\right) \sigma^2_{yh}{}'$$

$$= V(\bar{y}_h')$$

Hence

$\left(1 - \frac{n_h'}{N_h'}\right) \frac{s^2_{y_h'}}{n_h'}$ is an unbiased estimate of $V(\bar{y}_h')$

An unbiased estimate of the number of birds shot and retrieved (Y_h') is given in (3). It will be shown that

$$V\left(\frac{N_n}{n_h} y_h'\right) = \frac{N_h^2}{n_h} \sigma^2_{yh} \left(1 - \frac{n_h}{N_h}\right)$$

where σ^2_{yh} is the variance of the kill per hunter. Hence an unbiased estimate of variance is given by

$$\frac{N_h^2}{n_h}\left(1-\frac{n_h}{N_h}\right)s^2_{y_h}$$

where

$$s^2_{y_h}=\frac{1}{(n_h-1)}\left|\sum^{n_h'} y_{ih}^2-\frac{(y_h')^2}{n_h}\right| \qquad \ldots(8)$$

Proof :

$$V\left(\frac{N_h}{n_h}y'_h\right)=V\left(\frac{N_h}{n_h}n_h'\bar{y}_h'\right)=\frac{N_h^2}{n_h^2}V\left(n_h'\bar{y}_h'\right)$$

$$=\left[E_{n_h'}\,V(n_h'\;\bar{y}_h'/n_h')+V_{n_h'}\,E(n_h'\bar{y}_h'/n_h')\right]\frac{N_h^2}{n_h^2}$$

$$=\left\{E_{n_h'}\,n_h'^2\left(1-\frac{n_h^2}{N_h'}\right)\frac{\sigma^2_{y_h}{}^2}{n_h'}+V_{n_h'}\left(n_h'\bar{Y}_h'\right)\right\}\frac{N_h^2}{n_h^2}$$

$$=\left[\sigma^2_{y_h'}\,E_{n_h'}\left(n_h'-\frac{n_h'^2}{N_h'}\right)+\bar{Y}_h'^2\,V_{n_h'}\,(n_h')\right]\frac{N_h^2}{n_h^2}$$

Now, n_h' is a random variable following a hyper-geometric distribution

$$\text{Prob}\,(n_h')=\frac{\binom{N_h'}{n_h'}\binom{N_h-N_h'}{n_h-n_h'}}{\binom{N_h}{n_h}}\ \text{with}$$

$$E\,(n_h')=N_h'\frac{n_h}{N_h}$$

$$E\left[n_h'\;n_h'-1)\right]=\frac{N_h'(N_h'-1)}{N_h(N_h-1)}n_h(n_h-1)$$

From the last two relations it follows

$$E\,(n_h'^2) = \frac{N_h'}{N_h}n_y + \frac{N_h'(N_h'-1)}{N_h(N_h-1)}n_h\,(n_h-1), \text{ and}$$

$$V\,(n_h') = \left(\frac{N_h'}{N_h}\right)n_h\left[1-\left(\frac{N_y'}{N_h}n_h\right)-\frac{(N_h'-1)}{(N_y-1)}\left(n_h-1\right)\right]$$

Substituting the values of $E(n_h')$, $E(n_h'^2)$ and $V(n_h')$ in the expression for $V(N_h'\bar{y}_h')$ and collecting the terms containing $Y_h'^2$ we have

$$V\left(\frac{N_h}{n_h}y'_h\right) = \frac{N_h^2}{n_h}\left(1-\frac{n_h}{N_h}\right)\frac{1}{(N_h-1)}\left[\sum_{i=1}^{N_h'}y^2_{hi} - \frac{N'^2_h}{N_h}\bar{Y}'^2_h\right]$$

Now $\sum_{i=1}^{N_h'} y^2_{hi}, = \sum_{i=1}^{N_h} y^2_{hi},\ Y_h = N_h\ \bar{Y}_h = N_h\ \bar{Y}_h' = Y_h'$ and

that $y_{hi}=0$ for permit holders who are not active, we have

$$V\left(\frac{N_h}{n_h}y_h'\right) = \frac{\left(1-\frac{n_h}{N_h}\right)}{n_h}N_h^2\ S_h^2$$

where

$$S_h^2 = \frac{1}{N_h-1}\left(\sum_{i}^{N_h'} y^2_{hi} - \frac{Y_h^2}{N_h}\right)$$

Hence an unbiased estimate of $V\left(\frac{N_h}{n_h}y_h'\right)$ is given by

$$\frac{N_h^2}{n_h}\left(1-\frac{n_h}{N_h}\right)s^2 y_h \qquad \ldots(9)$$

$$s^2 y_h = \frac{1}{(n_h-1)}\left[\sum_{i}^{n_h'} y^2_{ih} - \frac{(y_h')^2}{n_y}\right]$$

6. Results and Discussion

It is proposed to present in this section the sample size required to estimate the provincial mean kill per hunter for a given margin of error, estimates of means and totals of some of the important characteristics.

6.1. Sample Size

The number of hunters expressed as percentage of the population required to estimate the provincial mean kill per Canadian male hunter with coefficient of variations of 5 and 10 per cent respectively is shown in Table 2. The method for estimating the sample size is available in standard texts and the reader is referred to Cochran (1963) for details.

Except for the eastern provinces of Newfoundland, Prince Edward Island, Nova Scotia and New Brunswick where a high sampling rate is required, to estimate the mean kill with a 5 per cent C.V., the sampling rates required in other provinces were reasonably low to provide estimates of the kill for the same accuracy. A sample size of less than 10 per cent would be sufficient in Newfoundland and Prince Edward Island and less than 5 per cent in others if it is desired to estimate the means with a 10 per cent C.V.

6.2. Estimates of Means/Totals of Characteristics

The estimate of total ducks bagged (Table 3) was consistently highest in Ontario, followed by Alberta; the lowest kill was registered by Prince Edward Island. This was mainly due to maximum number of successful hunters in Ontario followed by Alberta and high season bag of ducks per hunter in these provinces. The estimates of total ducks bagged showed a significant decline during 1968 in Ontario, Manitoba, Saskatchewan and Alberta owing mainly to a reduction in the number of ducks bagged per hunter and also in the number of successful hunters in all these provinces excluding Manitoba. In Newfoundland, Prince Edward Island, Nova Scotia and British Columbia the position remained practically unchanged mainly because the reduction in the season bag of ducks was made up by an increase in the number of successful hunters in these provinces. Both New Brunswick and Quebec registered increases owing to increase in both season bag of ducks and of successful hunters. A point of ecological interest is that in the eastern provinces (excluding New Burnswick) where the total number of ducks shot was relatively low and the province's relatively smaller in size, the number of ducks bagged per hunter tended to decrease with increase in the density of hunters ; there was, however, no such tendency in the major provinces where the total number of ducks shot was relatively high.

With regard to geese, there were pronounced falls in Quebec, Ontario, and Manitoba owing to a reduction in the number of hunters and/or geese bagged per hunter. In other provinces the differences were not significant. Saskatchewan showed the maximum number of geese bagged in both the years, the lowest figure being registered at New Brunswick.

The number of days hunted by an active, successful hunter remained unchanged during the period. The total man-days hunted by successful hunters showed increasing trends in Nova Scotia, New Brunswick and Quebec and decreasing trends in Ontario, Saskatchewan and Alberta. It is interesting to note that these trends were, as expected, similar to those in total ducks bagged which accounted for most of the waterfowl bagged by hunters.

7. Recent Developments

The mail surveys undertaken during 1967-68 and 1968-69 were based on stratified random samples with provinces as strata. An improvement in design was achieved by employing deeper stratification based on ecological zones as substrata.

The use of the previous year's list of permit holders as a sampling universe for the current year's hunting is likely to introduce bias in selection since such a sample will not include new hunters who did not buy a permit during the preceding year. A special survey (Sen, 1970), undertaken in Ontario has shown that the estimate of average kill of ducks for Ontario for 1967-68 has an upward bias to the extent of 8.5 per cent.

Analysis of the data from the Canadian Survers (Sen, 1971), conducted during 1967-68 and 1968-69 and from a special survey conducted in Manitoba during 1968-69 suggests that the bias due to non-response may not be serious. Further studies are underway to provide confirmatory evidence.

For management purposes, an important consideration is the effect of misreporting by hunters on the estimated total harvest due to deliberate misrepresentation resulting from pride, prestige, or poor memory. Survey experiments using bag-checks (Sen, 1971), conducted in the field showed that the response bias in the estimates of kill per day could be serious. Fifty per cent of the hunters observed to be unsuccessful during 1968-69 later reported having killed a duck and in the 1969-70 sample the proportion of false claims was twenty-eight per cent. Studies are underway to find the effect of response wave on response bias.

8. Summary

A national mail survey of Canadian waterfowl hunters was initiated in 1967 to provide, among other things, reliable estimates of the characteristics of the annual harvest. A stratified random sample, with provinces as strata and 1966 permit holders as ultimate units of sampling, was selected for the survey.

The present paper deals with the design of the survey, develops the theory of estimation for the Canadian waterfowl sample surveys and presents estimates and their errors for some of the important characteristics based on two years' data 1967-68 and 1968-1969. Recent developments in techniques have been briefly indicated.

TABLE 1

Sample Size and Response of Mail Respondents of Canada by Provinces based on 1968-67 and 1968-69 Mail Surveys

Province	*Questionnaires Mailed*		*Sample Size*		*Usable Response (Potential Hunters)*		*Response (Active Hunters)*	
	1967	*1968*	*1967*	*1968*	*1967*	*1968*	*1967*	*1968*
(*1*)	(*2*)	(*3*)	(*4*)	(*5*)	(*6*)	(*7*)	(*8*)	(9)
Newfoundland	2,576 (17·5)	4,468 (27.1)	2,273 (15·4)	3,167 (19·2)	676 (29·7)	1,446 (45 6)	561 (24·7)	907 (28·6)
Prince Edward Island	788 (25·8)	1,421 (41·0)	683 (22·3)	1,105 (31·9)	238 (34 8)	447 (40·4)	198 (29·0)	384 (34·7)
Nova Scotia	1,737 (22·5)	2,373 (28·1)	1,434 (18·6)	1,700 (20·1)	677 (47·2)	950 (55·9)	562 (39·2)	772 (45·4)
New Brunswick	1.955 (26·8)	2,221 (26·0)	1,626 (22.3)	1,669 (19·5)	736 (45·3)	902 (54·0)	610 (37·5)	725 (43·4)
Quebec	4,192 (13·3)	2,738 (8·3)	3,553 (11·3)	2,056 (6·2)	1,426 (40·1)	895 (43·5)	1,182 (33·3)	738 (35·9)
Ontario	8,146 (6·0)	6,220 (5·1)	6,637 (4·9)	5,003 (4·1)	3,366 (50·7)	2,449 (58·9)	2,791 (42·1)	1,946 (38·9)
Manitoba	3,804 (11·4)	3,065 (8·8)	2,894 (8.7)	2,640 (7·6)	2,025 (69·9)	1,496 (56·7)	1,679 (58·0)	1,288 (48·8)
Saskatchewan	4,458 (10·9)	3,748 (9·8)	3,555 (8·7)	2,861 (7·5)	2,010 (56.5)	1,522 (53·2)	1,666 (46·9)	1,268 (44·3)
Alberta	4,912 (9·1)	4,918 (9·8)	3,976 (7·4)	3,524 (7·1)	2.092 (52·6)	1,862 (52·8)	1,735 (43·6)	1,504 (42·7)
British Columbia	3,773 (11·9)	2,885 (9·4)	3,121 (9·8)	2,046 (6·7)	1,451 (46·5)	982 (48·0)	1,203 (38·5)	782 (38·2)
Total :	36,341 (10·1)	34,057 (9·8)	29,752 (8·3)	25,771 (7·4)	14,697 (49·4)	12,951 (50·2)	12,187 (41·0)	10,314 (40·0)

Figures in brackets in columns (2), (3), (4) and (5), show percentages to populations and in columns (6), (7), (8) and (9) to corresponding samples in columns (4) and (5).

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TABLE 2

Sample Size (per cent) required to estimate Provincial kill of ducks (excluding see ducks) for Canadian male hunters with 5% and 10% C.V. 1967-68 and 1968-69

Province	*Estimate Mean kill per hunter*		*Sample Size 5% C.V.*		*(per cent) 10% C.V.*	
	1967	*1968*	*1967*	*1968*	*1967*	*1968*
Newfoundland..	5·4	4·2	25·3.	15·1	7·3	4·0
Prince Edward Island	8.1	6·6	28·7	20·0	9·2	5·9
Nova Scotia	8·8	8·0	11·2	10·8	3·4	3·0
New Brunswick	7·2	8·1	11·0	10·2	3·3	2·8
Quebec	11·8	11·3	3·7	2 2	1·0	0·5
Ontario	8·4	7·5	1·0	0·8	0·3	0·2
Manitoba	11·4	9·0	1·7	1·9	0.4	0·5
Saskatchewan	12·7	8 0	1·3	1·4	0·4	0·4
Alberta	14·9	10·8	1·1	1·2	0·3	0·3
British Columbia	14·5	14·8	1·7	2·1	0 4	0·5

TABLE 3

Estimates of Means, Totals and their errors for Hunting Characteristics of Canadians of Males 1967-68 and 1968-69

	Nfld.		*P.E.I.*		*N.S.*		*N.B.*		*Que.*		*Ont.*		*Man.*		*Sask*		*Also.*		*B.C.*	
	'67	'68	'67	'68	'67	'68	'67	'68	'67	'68	'67	'68	'67	'68	'67	'68	'67	'68	'67	'68
Ducks																				
Number of successful Hunters × 10^{-3}	5·9 ± 0·2	7·1 ± 0.2	1·9 ± 0.1	2·2 ± 0·1	4·5 ± 0.1	5·0 ± 0·1	4·8 ± 0·1	6·3 ± 0·1	20·5 ± 0·4	25·0 ± 0·6	85·9 ± 1·1	83·1 ± 1·4	27·0 ± 0·3	27·2 ± 0·4	30·7 ± 0·4	28·6 ± 0·5	38·9 ± 0·5	35·3 ± 0·6	22·4 ± 0·4	23·6 ± 0·5
Season Bag per successful Hunter	8·6 ± 0·9	6·4 ± 0·3	10·9 ± 1·2	9·1 ± 0·6	12·0 ± 0·6	11·4 ± 0·6	8·9 ± 0·5	9·7 ± 0·5	14·4 ± 0·6	13·5 ± 0·6	10·9 ± 0·3	9·5 ± 0·3	13·2 ± 0·4	10·6 ± 0·4	14·4 ± 0·4	10·1 ± 0·3	16·5 ± 0·5	12·8 ± 0·4	16·6 ± 0·5	16·2 ± 0·7
Total Birds × 13^{-3}	51 ± 6	45 ± 3	21 ± 3	20 ± 2	54 ± 3	57 ± 3	43 ± 3	61 ± 4	295 ± 14	338 ± 18	937 ± 29	787 ± 29	356 ± 11	289 ± 11	442 ± 13	289 ± 11	654 ± 20	452 ± 16	370 ± 13	382 ± 19
Geese																				
Number of Successful Hunters × 10^{-3}	1·3 ± 0·1	1·7 ± 0·1	0·9 ± 0·1	1·2 ± 0.1	1·1 ± 0·1	1·4 ± 0·1	0·8 ± 0·1	0·8 ± 0·1	4·6 ± 0·3	4·3 ± 0·4	12·3 ± 0·7	9·0 ± 0·7	10·3 ± 0·4	6·7 ± 0·4	11·9 ± 0·4	13·0 ± 0·5	13·7 ± 0·5	13·8 ± 0·5	4·8 ± 0·3	5·2 ± 0·4
Season Bag per successful Hunter	3 0 ± 0·3	3·1 ± 0·6	4·0 ± 0·7	5·0 ± 0·5	4·6 ± 0·5	4·3 ± 0·4	2·7 ± 0·4	3·0 ± 0·4	5·9 ± 0·6	2·3 ± 0·2	3·3 ± 0·3	2·7 ± 0·3	3·4 ± 0·2	3·5 ± 0·3	4·8 ± 0 3	4·8 ± 0·2	3·9 ± 0·2	4·2 ± 0 2	3·1 ± 0·2	3·3 ± 0·3
Total Birds × 10^{-3}	3·9 ± 0·6	5·1 ± 1·0	3·6 ± 0·7	6·1 ± 0·7	5·0 ± 0·7	5·9 ± 0·7	2·2 ± 0·4	2·4 ± 0·4	27·1 ± 3·2	9.9 ± 1·4	40·6 ± 4·3	24·4 ± 3·1	35·0 ± 2·0	23·5 ± 2·3	57.2 ± 3·8	62·4 ± 4·0	53·4 ± 3·0	57·8 ± 3·4	14·9 ± 1·3	17·2 ± 2·0

TABLE 3 Contd. Heading

	Nfld. '67	*Nfld.* '68	*P.E.I.* '67	*P.E.I.* '68	*N.S.* '67	*N.S.* '68	*N.B.* '67	*N.B.* '68	*Que.* '67	*Que.* '68	*Ont.* '67	*Ont.* '68	*Man* '67	*Man* '68	*Sask* '67	*Sask* '68	*Also.* '67	*Also.* '68	*B.C.* '67	*B.C.* '68
Active Hunters																				
Average Days Hunted	9·0 ± 0·4	8·4 ± 0·3	11·4 ± 0·7	10·2 ± 0·4	9·6 ± 0·3	10·0 ± 0·3	6·7 ± 0·2	7·6 ± 0·7	8·6 ± 0·2	8·5 ± 0·3	6·7 ± 0·1	6·7 ± 0·1	6·5 ± 0·1	6·4 ± 0·1	7·1 ± 0·2	6·4 ± 0·2	7·0 ± 0·2	6·4 ± 0·2	8·7 ± 0.3	8·8 ± 0·3
Total Man Days $\times 10^{-4}$	8·5 ± 0·5	9.2 ± 0·4	2·9 ± 0·2	3·2 ± 0·1	5·9 ± 0·2	7·3 ± 0·3	3·9 ± 0·2	5·9 ± 0·6	21·8 ± 0·7	26·1 ± 0·9	74·1 ± 1·5	74·4 ± 1·8	20·5 ± 0·4	21·2 ± 0·6	24·9 ± 0·6	23·3 ± 0·7	30·4 ± 0·7	27·8 ± 0·7	22·2 ± 0·8	23·3 ± 0·9
Successful Hunters																				
Average Days Hunted	10·5 ± 0·5	9·2 ± 0·4	12·4 ± 0·8	11.4 ± 0·5	10·5 ± 0·4	11·3 ± 0·3	6·9 ± 0·3	8·3 ± 0·8	9·2 ± 0·3	9.3 ± 0·3	7·5 ± 0·1	7·6 ± 0·2	6·9 ± 0·1	7·0 ± 0·2	7·5 ± 0·2	6·9 ± 0·2	7·3 ± 0·2	6·9 ± 0·2	9·3 ± 0·3	9·3 ± 0.3
Total Man Days $\times 10^{-4}$	6·8 ± 0·5	7·2 ± 0·4	2·6 ± 0·2	2·9 ± 0·1	5·4 ± 0·2	6·6 ± 0·3	3·4 ± 0·2	5·3 ± 0·6	19·7 ± 0·7	24·4 ± 1·0	65.3 ± 1·6	64.6 ± 1·9	19·3 ± 0·4	19·6 ± 0·6	23.8 ± 0·6	21·6 ± 0·7	29·3 ± 0·7	25·8 ± 0·7	21·2 ± 0·8	22·4 ± 0·1

CORRIGENDA

to

EFFICIENCY OF T-STATISTICS FOR TESTING TWO NORMAL SAMPLES

by

P.V. Krishna Iyer, B.N. Singh and M.S. Holla

(*Journal of the Indian Society of Agricultural Statistics, Vol. XXIII, No. 2, December 1971*

Clause Ref.	*Please Read*	*For*
Introduction, third para, third line (p. 36)	s	S
Clause 2, Expression (3) (p. 37)	$z_{i,\ i+k-1}$ where $z_{i,\ i+k-1}=1$ if......and zero otherwise.	$z_i, i+k-1$ where $z_i, i+k-1=1$ if...... ......and zero otherwise.
Clause 3 (p. 38)		
(*i*) First para, first line	z_s	z_r
(*ii*) First para, first line	ρ_{i1}	ρ_{il}
(*iii*) Expression (5)	$(z_{i,i+1})$	$(z_i,\ i+1)$
(*iv*) Twelfth line	ρ_1 and ρi_1	ρ_k and ρ_{ik}
(*v*) Experession (9)	$E\,(T_k)\sum_{l=2}^{k}(s-l+1)\rho_{l-1}$	$E(T_k)\sum_{1=2}^{k}(s-1+1)\rho_{l-1}$
Expression for $V(T_k)$ (p. 38)		
(*i*) Fourth line	$k-2$ or less than $k-2$	k or less than k
(*ii*) Seventh line	0, 1, 2, ... $(k-2)$	1, 2,...... $(k-1)$

Clause Ref.	*Please Read*	*For*
Expression (11) (p. 39)		
(*i*) Third line	$\triangle\theta t$	δt
(*ii*) Fifth line	θ_u	θ_k
(*iii*) Sixth line	$f(z_i, \theta)$	$f(z, \theta)$
Expression (13) (p. 39)	$\triangle\theta t$	δt
Expression (14) (p. 39)	ρ_{icd}	ρ_{jcd}
Last but one line (p. 39)	$\dfrac{f'(z)}{f(z)}$	$\dfrac{f'(z)}{f^2(z)}$
Expression for $\rho icde$ (p. 40)	$n^{(2)}$	$n^{(?)}$
Expression (20) second and third lines (p. 40)	$\left\{1-\frac{2mn}{s}\right\}+\frac{2m^{(2)}n^{(2)}}{s(4)}\Big\{\mu(s-2)(s-3)$ $\times\left(\frac{(n-1)}{s-2}\ \frac{n}{s}-\frac{m-2}{s-3}-\frac{m-1}{s-1}\right)$ $+\ldots\ldots\frac{2n}{s}\Big((s-3)z_1+(s-4)z^2$ $+\ldots\ldots z_{s-3}\Big)\Big\}\Big]$	Existing lines
Expression (25) (p. 41)	$E(T_{s-k})$	$E(T_{s-k})$
Expression (26) last line (p. 41)	$K(K-1)$	$K(k-1)$
Clause 4, second line (p. 41)	(1964)	(1966)
Clause 4, second para, fourth line (p. 41)	$\dfrac{\rho n^{*2}}{\left\{\dfrac{\theta\mu n^{*}(\theta)}{d\theta}\right\}^2}$	$\dfrac{\rho n^{*2}}{\left\{\dfrac{d1(\theta)}{d\theta}\right\}}$
Last but one para, second line (p. 42)	H_1	NB_1
Third line from the bottom (p. 42)	T_r's	T'_r