RESPONSE ERRORS IN CANADIAN WATERFOWL SURVEYS[1]

A. R. SEN, Canadian Wildlife Service, Department of the Environment, Ottawa, Ontario K1A OH3

Abstract: Survey experiments based on bag check were initiated by the Canadian Wildlife Service during 1968–69 in a few study areas in Eastern Canada to provide information on the extent of response bias in the estimates of the characteristics of the harvest from mail surveys on specific days of the season. The responses were checked in the field and queried on the questionnaire. The experiments were modified during 1969–70 to cover a larger sample and provide estimates of the hunter's kill, that of his party, and of the bias due to memory lag of the hunter. The present paper considers the effect of memory lag, response wave, and size of waterfowl harvest on the response bias and the accuracy with which the species composition of the kill was reported by the waterfowl hunter. We show that the response bias is positive and highly significant and was, on the whole, 60 percent of the mean of field records when data for both successful and unsuccessful hunters were combined; in addition it was consistently higher for the follow-ups than for the first questionnaire. However, when successful hunters alone were considered, the bias was only 16 percent of the field mean and there was no apparent increase in bias for the follow-up questionnaire. Although these studies do not provide a reliable basis for estimating response errors for the entire season in the Canadian Mail Surveys they do suggest that the estimates of kill for all hunters (successful and unsuccessful combined) may be subject to considerable positive bias; but the bias may not be serious when the reports from successful hunters alone are considered. Species composition of the kill was reported with a reasonable degree of accuracy for certain important species.

J. WILDL. MANAGE. 37(4):485–491

INTRODUCTION

Response bias in reporting hunting experience from mail surveys of hunters has been investigated by several workers and most extensively by Atwood (1956) with special reference to waterfowl hunting. Hjersman (1951) and Nelson (1951) reported that the estimates of seasonal kill based on mail survey data were subject to positive error. Atwood found that the response errors for the first mailings in Fountain Grove Public Hunting area during 1952–53 varied from 56 percent of the true mean to 168 percent in Lower Klamath Public Hunting area; when the sampling and nonsampling errors were also taken into account, the corresponding figures were 53 and 168 percent of the true means. For the second mailings the corresponding figures were 59 and 153 percent for response errors and 59 and 149 percent for survey error (response plus sampling plus nonresponse error). From these studies Atwood (1956) concluded that response errors are large compared to sampling and nonresponse errors taken together, and that their presence very seriously limits the usefulness of the survey data.

From a study of survey errors in nine public hunting areas Hayne (1964) reported that the response error in the estimates of ducks bagged varied from 11 to 57 percent of the mean of field records as against nonresponse plus sampling error which ranged from 1.5 to 28 percent. From these studies Hayne (1964) deduced that estimates of kill computed directly from hunter's reports are subject to serious positive bias and that nonresponse bias was generally less important than response bias.

In Canada mail surveys of waterfowl hunters have been conducted on an annual basis since 1967 to provide, among other things, reliable estimates of the characteristics of the annual harvest. The sampling

[1] Presented at the annual meetings of American Statistical Association and Biometrics Conference, Detroit, Michigan, December 1970.

Table 1. Number of questionnaires mailed and replies received, 1969–70.

	Interval between field interview and questionnaire issuance					
	1 week	2 weeks	3 weeks	4 weeks	8 weeks	Total
Number sent	49	49	48	49	47	242
Replies received	24	22	32	28	26	132
Follow-up sent	23	26	15	21	20	105
Replies received	13	17	11	13	11	65
Total replies	37	39	43	41	37	197
Undeliverables	2	1	1	0	1	5
Incomplete replies	1	2	7	3	1	14
Usable replies	36	37	36	38	36	183
Nonrespondents	10	9	4	8	9	40

universe of the Canadian waterfowl harvest survey consists of hunters who bought Canadian migratory game bird hunting permits during the previous year. The sampling plan of the surveys includes postseason contacts of hunters through mailed questionnaires for obtaining estimates of hunting take. Hence response bias of large magnitude resulting from pride, prestige, or memory lag may occur in such surveys of the waterfowl hunter.

BAG-CHECK STUDY 1968–69

Accordingly a bag-check experiment was initiated by the Canadian Wildlife Service during 1968–69 in a few study areas in the eastern region. Regional biologists collected data on the bag of waterfowl from a sample of hunters on the spot twice every week (a fixed week day and a Saturday). The study areas selected were typical of waterfowl hunting areas in terms of location, ecological pattern, and type of hunting in the region. They had, as far as possible, well marked natural boundaries and were open to the public with conditions favorable for accurately recording waterfowl hunting. Although it was believed that not many public hunting areas would meet all these requirements, an attempt was made to find areas which did fulfill them. At a suitable contact point in a selected area, one hunter from each party in the area was interviewed on a specified day. Waterfowl knocked down and retrieved by him were recorded for the day, by species as observed by the hunter and by the biologist; also the hunting license number, name, and address of the hunter were recorded. Following the hunting, the hunter was mailed a questionnaire requesting information on his hunting (waterfowl killed and retrieved) in the particular area on the specific dates he was checked in the field. The questionnaire information was then compared with his known record for the area. The object of the study was to measure the bias in response of waterfowl hunters to mail questionnaires concerning bag or when reporting the species of the kill. Except for the data from Lake St. Peter area where the objectives of the study and the purpose of the questionnaire were fully understood, the questionnaires did not generally permit separation of the response of the individual hunter from those belonging to the party and the usable response was rather low to provide valid and reliable conclusions. However, results from the 1968–69 study indicated that the species composition of the kill was reported with fair accuracy. This point was examined more fully in the 1969–70 study.

Table 2. Hunter's statement of species composition of ducks compared with that of the biologist as made in the field, 1969–70.

	No. of hunters reporting	Hunter's score	Biologist's score	Mean diff. ($\bar{p}$) Col. (3)–Col. (4) / Col. (2)	SE ($\bar{p}$)	Col. (5) / Col. (6)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Black duck	33	37	38	0.03	0.11	0.27
Mallard	33	41	41	0		
Teal	54	155	141	0.26	0.19	1.37
Blue-winged	25	34	77	1.72	1.18	1.46
Green-winged	32	50	63	0.41	0.15	2.73*
American widgeon	8	5	11	0.75	0.20	3.75**
Gadwall	10	2	16	1.40	0.27	5.18***
Pintail	8	8	10	0.25	0.25	1.00

* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$.

BAG-CHECK STUDY 1969–70

During 1969–70, the survey was better organized and its scope extended to cover hunting areas from New Brunswick, Nova Scotia, and Ontario. The mail questionnaire was redesigned to make it easier for the hunter to fill in and was issued 1, 2, 3, and 4 weeks from the date of the field interview and at the end of the season. The purpose of splitting samples selected randomly was to find the effect of memory lag on response bias. The name, address, and other details were recorded in the field by the biologist during interview.

The mean ducks bagged per day by the hunter in the field and those reported by him were estimated for both successful and active (an active hunter is one who participates in hunting whether he is successful or not) hunters. Some of the results from the surveys for the two years, 1968–69 and 1969–70, have been presented briefly by Sen (1971, 1972). The present study considers the effect of memory lag and response wave on the response bias on the basis of 1969–70 survey data; estimates of bias have also been obtained for both successful and active hunters. The data were also analyzed to determine the extent to which a hunter was able to report accurately the species composition of the kill as judged by the biologist.

My thanks to the biologists of the Eastern region for the collection of the data, to Miss Barbara Wills for helping in their analysis, and to the referees for some helpful comments.

Table 3. Ratio of ducks reported as bagged (K_r) by active hunters to that bagged (K_a), and of the number of unsuccessful hunters reported (N_r) to the number of unsuccessful (N_a) hunters for different periods, 1969–70.

	Interval between field interview and questionnaire issuance					
Ratios	1 week	2 weeks	3 weeks	4 weeks	8 weeks	Total
K_r/K_a	1.77 ± 0.34	1.54 ± 0.23	1.72 ± 0.23	1.48 ± 0.23	1.52 ± 0.26	1.53 ± 0.11
N_r/N_a	0.59 ± 0.11	0.65 ± 0.10	0.80 ± 0.08	0.65 ± 0.10	0.86 ± 0.11	0.71 ± 0.04

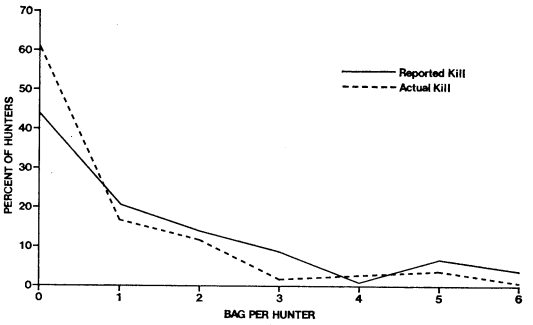

Fig. 1. Frequency distribution of ducks bagged and ducks reported bagged in Eastern Canada, 1969–70.

RESPONSE

The total number of questionnaires mailed, the interval from interview to mailing, and the replies received are given in Table 1. Of the 242 questionnaires issued, only 75 percent (183) were usable as far as individual hunter responses are concerned. In 6 percent of the cases, the hunter did not provide his kill either in the field or in the questionnaire, or in both. The undeliverable questionnaires comprised 2 percent and the remaining 17 percent consisted of nonresponses.

RESULTS

To measure the accuracy with which the species composition of ducks was reported by the hunter, his statement of the species bagged in the field was compared with that of the biologist's observations. The combined data for Sackville and Ontario presented in Table 2 show the average hunter was able to distinguish common species in the region, i.e., mallards (*Anas platyrynchos*) and black ducks (*A. rubripes*) most accurately, followed by pintail (*A. acuta*), for which the results are based on a small sample. The discrepancies were rather pronounced (but not significant) for blue-winged teal (*A. discors*) and significant ($P < 0.05$) for green-winged teal (*A. carolinensis*); the hunter was, however, able to distinguish the species within the broad category of teal with a reasonable degree of accuracy. The discrepancies were highly significant for American widgeon (*Mareca americana*) ($P < 0.01$) and gadwall (*A. strepera*) ($P < 0.001$).

The ratio of ducks reported to have been killed and retrieved to that bagged by active hunters and of the number of hunters reported unsuccessful to the number of unsuccessful hunters at the end of different periods are shown in Table 3. There was a consistent tendency for active hunters to report a higher kill than the number bagged when questionnaires were sent after 1, 2, 3, 4, and 8 weeks (i.e., at the end of the season) from the date of hunting; also, the number of unsuccessful hunters as reported was consistently lower than the actual num-

Table 4. Discrepancy between reported kill and that obtained in field by bagsize, 1969–70.

Bag	Number of hunters bagging	Total ducks bagged	Total ducks bagged as reported	Discrepancy	Mean discrepancy	SE of mean discrepancy
0	112	0	71	71	0.63***	0.12
1	30	30	45	15	0.50**	0.19
2	22	44	47	3	0.14	0.11
3	3	9	13	4		
4	6	24	27	3	0.42	0.26
5	8	40	41	1		
6	2	12	12	0		

* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$.

Table 5. Questionnaire response compared with known hunting performance for active and successful hunters, 1969–70.

Area	Sample size	No. of successful hunters		Mean no. of ducks taken by active hunters		Response bias as proportion of ducks bagged	Mean no of ducks taken by successful hunters		Response bias as proportion of ducks bagged
		Quest.	Field check	Quest.	Field check		Quest.	Field check	
Ontario	121	63	40	1.06*** ± 0.12	0.60*** ± 0.10	0.77** ± 0.22	1.99*** ± 0.19	1.82*** ± 0.18	0.09 ± 0.06
New Brunswick and Nova Scotia	62	40	31	2.06*** ± 0.28	1.39*** ± 0.24	0.48** ± 0.15	3.41*** ± 0.37	2.77*** ± 0.34	0.23* ± 0.08
Total	183	103	71	1.39*** ± 0.13	0.87*** ± 0.11	0.60*** ± 0.13	2.61*** ± 0.20	2.24*** ± 0.18	0.16** ± 0.05

* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$.

ber of such hunters as found in the field. The bias tended to decrease towards the end of the season. Since the field interviews referred to specific days of the season, these do not provide a reliable basis for estimating the response errors based on the entire season as in the Canadian harvest surveys. However, the experiments do suggest that the kill reported by the hunter may be subject to substantial positive bias.

It may be argued that some hunting activity that occurred at other times or even possibly on the same day but at a later time could also have been included in the hunter's report. These additional hunting activities are likely to raise K_r/K_a and depress N_r/N_a values presented in Table 3. On the other hand, it could be that field interviews with the hunter being on a specific date and in a specific area during the season would serve as an aid to recalling his kill, date, and place of interview. Also, perhaps, the hunter could recall more accurately smaller kills based on a single day's activity as compared to increasingly larger totals resulting from several or a number of days of activity. This point needs further investigation.

The frequency distribution of hunters by percent ducks bagged is shown in Fig. 1 which shows the extent of exaggeration in the hunter's reported kill as compared with the actual. Thus, 61 percent of the hunters contacted on the specific days in the field were unsuccessful but only 44 percent reported success. Table 4 shows the average discrepancy between reported kill and the actual by bag size. Because too few hunters bagged 3 or more birds, the kill of these latter hunters have been combined to yield an over-all estimate. The discrepancies are highly significant ($P < 0.01$) for bag sizes 0 and 1, but none of the discrepancies was significant for bag sizes exceeding one.

Table 6. Response bias expressed as proportion of mean numbers of ducks bagged for active and successful hunters, 1969–70.

Area	Active hunters			Successful hunters		
	Quest.	Follow up	Increase	Quest.	Follow up	Increase
Ontario	0.35*	1.89*	1.54	0.09	0.05	(-0.04)
	±	±	±	±	±	±
	0.15	0.87	0.89	0.07	0.10	0.12
	(77)[a]	(44)		(30)	(10)	
New Brunswick	0.43**	0.78*	0.35	0.19*	0.43*	0.23
	±	±	±	±	±	±
and Nova Scotia	0.14	0.39	0.42	0.07	0.20	0.19
Total	0.40***	1.42*	1.09*	0.15*	0.21*	0.06
	±	±	±	±	±	±
	0.11	0.53	0.54	0.07	0.17	0.18
	(124)	(59)		(55)	(16)	

* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$.
[a] Figures in parentheses show the sample sizes on which the estimates are based.

The mean ducks bagged per day by the hunter in the field and those reported by him for both active and successful hunters are presented in Table 5. The response bias has been estimated as the increase in mean number of ducks killed and retrieved as reported by the hunter, over that bagged by him expressed as proportion of the mean number bagged. Based on hunter reports, both the mean number of ducks bagged and the proportion of successful hunters were subject to serious positive bias in both the areas. Twenty-eight percent of the unsuccessful hunters in one area (Ontario) and 29 percent in the other reported that they killed one or more ducks each. The average kill reported by the active hunters in the sample in the two areas were respectively 77 and 48 percent higher than the corresponding true kills. If, however, we exclude active hunters who had no kill and only consider successful hunters, the estimates of kill reported are respectively 9 (non-significant) and 23 percent higher than the corresponding true kills. For the two areas taken together, the corresponding increases were respectively 60 and 16 percent for active and successful hunters. The studies suggest that the estimate of kill of the active hunters may be subject to considerable response bias which is attributed mainly to the tendency on the part of unsuccessful hunters to report success.

The response bias for the different waves of response (first questionnaire and the follow-up) for both active and unsuccessful hunters is shown in Table 6. For active hunters, the estimated bias for both the questionnaire and the follow-up was positive and significant in the two areas. Also, the bias was consistently higher for the follow-up than for the questionnaire; the over-all increase in bias for the two areas taken together was significant ($P < 0.05$). If, however, unsuccessful active hunters are excluded from the study, the resulting bias for successful hunters was found to be of a much lower order and significant ($P < 0.05$) only in one of the areas; also the bias for the follow-ups was higher in one and lower in the other and the over-all increase in bias was small and negligible. The increase in response bias for the follow-ups over that for the questionnaire is, therefore, mainly

due to a greater reluctance on the part of the unsuccessful hunters to respond to the first questionnaire, and then to report they were successful when responding to the follow-up.

LITERATURE CITED

ATWOOD, E. L. 1956. Validity of mail survey data on bagged waterfowl. J. Wildl. Manage. 20(1):1–16.

HAYNE, D. W. 1964. Investigation of mail survey reporting by waterfowl hunters. Report prepared for U.S. Bur. Sport Fish. and Wildl. Institute of Statistics, North Carolina State Univ., Raleigh. 24pp.

HJERSMAN, H. A. 1951. The 1948 surveys of California's hunting take and their significance. California Fish Game. 37(1):77–95.

NELSON, N. F. 1951. Waterfowl kill by questionnaire card and surveys. Utah Pacific Flyway Rep. 14.

SEN, A. R. 1971. Some recent developments in waterfowl sample survey techniques. J. R. Stat. Soc. 20(2):139–147.

———. 1972. Some nonsampling errors in the Canadian waterfowl mail survey. J. Wildl. Manage. 36(3):951–954.

Accepted 22 March 1973.