A Comparison of 1990–1991 State and Federal Goose Harvest Estimates for Tennessee

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Abstract: A multi-phase mail and telephone survey of 9,000 hunters was used to estimate the harvest of Canada geese (*Branta canadensis*) in Tennessee during the 1990–91 hunting season. The estimate, 13,429 (CI ± 2,469), was substantially lower than that produced by the annual waterfowl harvest survey conducted by the U.S. Fish and Wildlife Service for that same period. If a high degree of accuracy is needed by states when formulating season framework and harvest recommendations, a detailed state-specific survey may be needed. Methods for conducting a scaled-down version of this survey that would meet that objective are discussed.

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Canada goose populations throughout much of the country have increased significantly in recent years (Tacha et al. 1991). This population increase has resulted in harvest increases in many states including Tennessee, but the reliability of the annual waterfowl survey conducted by the U.S. Fish and Wildlife Service (USFWS) to monitor harvest at the state level is not known. The USFWS's harvest figures are generated from a survey of hunters buying Federal Migratory Bird Hunting and Conservation Stamps (duck stamps) from 3,000 post offices throughout the country (Geissler 1990). From this sample, the USFWS mails approximately 70,000 questionnaires nationwide. The sample size for a given state may be quite small; for example, the waterfowl harvest estimate (including Canada geese) for Tennessee during the 1989–90 season was based on 641 responses (Martin et al. 1991). Few studies have compared results among surveys, but generally, state harvest estimates show larger harvests than the federal survey (Grimes 1982). Geissler (1990) indicated that state-level estimates are less precise than those for flyways, and that apparent changes in harvest may sometimes actually be due to sampling variability.

Annual estimates of the Canada goose harvest in Tennessee for the period 1983–88 ranged from 12,200 to 20,800 with an average of slightly over 16,000 (Gamble 1991). During the 1989–90 season, the estimated harvest more than tripled

to 55,271 (Martin et al. 1991). While Tennessee waterfowl managers acknowledged that wintering goose populations were larger than normal (E. L. Warr, pers. commun.), an apparent harvest increase of this magnitude was of concern to both the USFWS and the Tennessee Wildlife Resources Agency (TWRA) and highlighted our lack of knowledge regarding accuracy of the federal survey at the state level.

Since reliable harvest data are needed to properly manage waterfowl resources, this study was conducted to evaluate the accuracy of the federal estimate of the goose harvest in Tennessee. Secondary objectives were to partition the harvest among the major management zones and Harvest Quota Units (HQU) in the state and to refine techniques for conducting future surveys.

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Methods

We used a multi-phase survey employing mail questionnaires and a telephone follow-up of non-respondents to generate an estimate of the Canada goose harvest in Tennessee during the 1990–91 season. The results of that survey were then compared with the USFWS estimate for the same period. Although mail surveys have been used most extensively in government, politics, business, and industry (Erdos and Morgan 1970, Babbie 1973), the wildlife management profession has also recognized their value. Mail and other types of social surveys may be used to study a wide range of wildlife-based and wildlife-related human activities, values, and characteristics (Filion 1980). Advantages of mail surveys over telephone or personal interviews include absence of interviewer bias and increased cost efficiency (Erdos and Morgan 1970). Non-response bias and over-reporting of harvest are problems sometimes associated with mail surveys (Filion 1980, Grimes 1982), but use of follow-up letter or postcard reminders, additional questionnaires, and personal or telephone interviews can minimize these negative impacts (Erdos and Morgan 1970, Filion 1978). Surveys based on multiple contacts have been found to have 2 significant advantages over single-contact surveys. First, they result in a higher rate of return and second, provide a means of determining non-response bias (Filion 1980).

The harvest survey consisted of 3 separate mailings to 9,000 hunters. Sample size was calculated according to Walpole (1968) using harvest statistics gathered on quota hunts in the eastern part of the state during the 1989–90 season (E. L. Warr, pers. commun.). Since a high degree of accuracy was desired, values reflecting a relative precision of 10% with a confidence level of 95% were used. Using these

criteria, the sample mean plus or minus 10% of the sample mean will bound the true mean 95 times out of 100.

The initial mailing, composed of the questionnaire, a cover letter explaining the study and soliciting a response, and a self-addressed, postage-paid reply envelope, was sent in April 1991 to each of the license buyers in the sample. Envelopes were personalized by addressing them with a laser printer and by stamping them with TTU's 75th anniversary logo. Approximately 3 weeks after the initial mailing, a post card reminder was mailed to each person encouraging them to reply to the questionnaire if they had not already done so. The final mailing consisting of the same questionnaire, another cover letter, and another self-addressed, postage-paid reply envelope was sent to individuals who had not responded to either of the first 2 contacts. After allowing time for a response to this final mailing, 130 non-respondents were contacted by telephone to determine what their harvest statistics were. Approximately 500 persons were called to obtain the sample of 130.

Persons contacted in the study were selected from a list of approximately 10,000 names obtained by the TWRA from a random sample of license sales records. The license categories included in the study were: senior, sportsman, waterfowl, nonresident junior hunt/fish, nonresident hunt-small game/waterfowl, and nonresident 7-day hunt-small game/waterfowl. Total sales for these categories during the 1990–91 season were: senior—3,470; sportsman—31,903; waterfowl—11,952; nonresident junior hunt/fish—4,296; nonresident hunt-small game/waterfowl—1,485; nonresident 7-day hunt-small game/waterfowl—3,383. Since it was believed that most goose hunters purchase the waterfowl license, the largest sample (4,906) was from this group. The remaining questionnaires were distributed as follows: senior—523; sportsman—2,000; nonresident junior hunt/fish—263; nonresident hunt-small game/waterfowl—629; and nonresident 7-day hunt-small game/waterfowl—679. Approximately 1,000 names in the waterfowl group were removed from the original list submitted by the TWRA by systematically deleting every fifth name until the number desired was obtained. In the other categories, all the names submitted were contacted. Junior hunters were not included in the survey, with the exception of the small sample in the nonresident category, since it has been shown that they contribute little to the overall harvest (P. H. Geissler, pers. commun.) and that their inclusion in some state surveys was not a significant factor when comparing state and federal estimates (Grimes 1982).

Although estimates of the Canada goose harvest were calculated for the entire state, the 4 major management zones, and the HQU's; this paper discusses only the statewide results. Harvest estimates were calculated from total sales of each license type sampled in a stratified manner (Cochran 1977). The proportion of hunters that considered themselves to be waterfowl hunters and total number of waterfowl hunters by license type were also calculated. Procedures for obtaining totals, means, and proportions using stratification in 2-phase sampling were adapted from Kish (1965). The mean harvest estimate per hunter was calculated for each mailing and the telephone survey and was then multiplied by the proportion of hunters responding to each contact as follows:

$$\bar{y}_{wd} = \Sigma\, w_h\, \bar{y}_h$$

where, w_h = estimated proportion of hunters in the h^{th} strata.

$\bar{y}_h$ = mean harvest for the h^{th} strata.

Then $\hat{Y}$ was calculated using the following formula from Cochran (1977:22).

$$\hat{Y} = N\bar{y}_{wd}$$

where, N = total number of licenses sold of that type.

$\bar{y}_{wd}$ = the final mean calculated in the above formula.

$$\text{var}(\bar{y}_{wd}) = \Sigma\, w_h^2\, s_h^2/n_h + 1/n_L\, \Sigma\, w_h(\bar{y}_h - \bar{y}_{wd})^2$$

where, w_h = estimated proportion of hunters in the h^{th} strata.

s_h^2 = variance of the license type for which the total variance is being calculated.

n_h = number of hunters sampled in the h^{th} strata.

n_L = number of hunters sampled of that license type.

This gives the variance of the final mean. The total variance of each license type was then calculated using the following formula.

$$V_t = N^2 \text{var}(\bar{y}_{wd})$$

where, N = the total number of license buyers of each type. The total variance was then calculated by summing the variances of the individual license types. The calculations for the Waterfowl license type are as follows:

$$\bar{y}_{wd} = 1645/4906(1.2103343) + 586/4906(0.9453925) + 2675/4906(0.3934426) = 0.7332773921645$$

$$\hat{Y} = 11952(0.7332773921645) = 8764.13$$

$$\text{var}(\bar{y}_{wd}) = (1645/4906)^2\,(18.5944187/1645) + (586/4906)^2\,(7.3918847/586) + (2675/4906)^2\,(0.9092896/61) + 1/4906\,[1645/4906\,(1.2103343 - 0.733277392)^2 + 586/4906\,(0.9453925 - 0.733277392)^2 + 2675/4906\,(0.3934426 - 0.733277392)^2 = 0.005911946$$

$$V_t = (11952)^2\,(0.005911946) = 844523.22$$

The Statistical Analysis System (SAS 1985) was used for data handling and statistical analyses. SAS programs used in the calculations are shown in Jones (1993).

Results

After all mailings, 503 (5.6%) of the 9,000 questionnaires were returned as non-deliverable by the post office; therefore, 8,497 hunters participated in the survey. Of these, 3,724 (43.8%) returned the questionnaire and 4,773 (56.2%) were non-respondents.

The statewide harvest of Canada geese during the 1990–91 season following both mailings and the additional 130 telephone calls was estimated to be 13,429 with a 95% confidence interval of ± 2,469. Our final estimate of the harvest was much lower than if we had relied on only the first mail solicitation. For example, the harvest estimate based on questionnaires returned after the first mailing was 27,103, more than double our final figure. These results support the widespread belief that successful hunters are most likely to respond to first mailings while less successful hunters respond to later mailings (Fig. 1).

Waterfowl license holders harvested more Canada geese (8,764) than hunters who purchased other license types. Sportsman's license holders ranked second with a total harvest of 4,525. In combination, these 2 groups accounted for 98.9% of the total goose harvest (Table 1). Purchasers of the waterfowl license were largely waterfowl hunters (89% of 11,952), while the proportion was much smaller in the other categories (Table 2). Only 21% of the hunters who bought the sportsman's license considered themselves to be waterfowl hunters. However, since many hunters prefer the convenience of this type of license, the number of potential waterfowl hunters in this group is quite large (6,700).

Discussion

The estimate of the Canada goose harvest generated by this survey is substantially lower than the preliminary figure of 23,720 produced by the USFWS (Martin

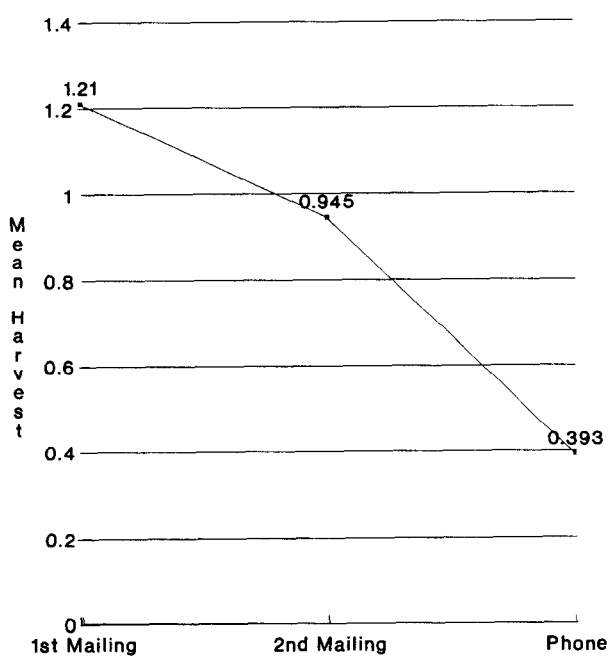

Figure 1. Mean harvest estimates for purchasers of the Waterfowl type license based on the 2 mailings and a follow-up telephone survey.

Table 1. Harvest of Canada geese by license holder type in Tennessee during the 1990–91 waterfowl hunting season.

License type	Total harvested	95% CI	
		Lower	Upper
Senior	7	0	20
Sportsman	4,525	2,838	6,212
Waterfowl	8,764	6,963	10,565
NR[a] jr. hunt/fish	0	0	0
NR hunt-small game/waterfowl	28	0	56
NR 7-day hunt-small game/waterfowl	105	29	181

[a]NR = Nonresident

Table 2. Proportion and number of waterfowl hunters in Tennessee by license type during the 1990–91 hunting season.

License type	Total sales	Proportion waterfowl hunters	Total waterfowl hunters
Senior	3,470	3%	104
Sportsman	31,903	21%	6,700
Waterfowl	11,952	89%	10,637
NR[a] jr. hunt/fish	4,296	1%	43
NR hunt-small game/waterfowl	1,485	18%	267
NR 7-day hunt-small game/waterfowl	3,383	20%	677

[a]NR = Nonresident

et al. 1991). The USFWS estimate could change as additional data become available; however, such changes are normally slight (E. L. Warr, pers. commun.). It is noteworthy that even our upper confidence limit of 15,897 was much lower than the USFWS estimate. Confidence limits for the USFWS survey were not reported by Martin et al. (1991).

Because our survey was based on only 1 hunting season, it was not possible to make multiple year comparisons which would have provided more insight into the accuracy of the USFWS survey. However, given the magnitude of the difference in the estimates, there seems to be reason for caution if states such as Tennessee base their management recommendations solely on the federal survey results.

The study design we employed coupled with a large sample size, enabled us to calculate a reliable estimate of Tennessee's Canada goose harvest. The 95% confidence interval around the mean harvest is small ($\pm$ 18.4%), falling within the range considered acceptable by Geissler (1990). However, large surveys such as this are costly, time consuming, and impractical to conduct on a routine basis. When states need accurate harvest data, they should consider using our study design but reducing the number of hunters sampled to the minimum necessary to obtain the desired

accuracy. The following example uses our data and formulas from Cochran (1977) for calculating sample sizes:

$$n = \frac{\Sigma W_h s_h^2}{(d/t)^2}$$

where n is the estimated sample size, W_h is the proportion of license holders of the h^{th} strata, s_h^2 is the variance of the h^{th} strata, d is the margin of error, t is the normal deviate corresponding to the allowable probability that the error will exceed the desired margin.

With 6 license types and accepting a 10% margin of error at the 95% confidence level, the recommended sample size is 1,839. Increasing the number of participants that must be surveyed to allow for non-response (56.2% in our study) inflates the total to 4,199. This is a substantial reduction from our sample of 9,000. By lowering the confidence level to 90%, the number of hunters surveyed can be reduced to an even more manageable 2,985.

Three other points should be considered when designing harvest surveys. First, states should focus only on license buyers who are responsible for the majority of the harvest. This will reduce the survey effort somewhat, although sample size may not decrease as much as might be expected if, as in our study, nonresident, senior, and similar groups contribute little to the overall harvest. For example, eliminating the 4 categories of hunters that contributed little to the 1990–91 harvest results in reducing the recommended sample size to 2,953 at the 90% confidence level. Second, hunters should be contacted prior to the waterfowl season and provided a form on which they record their daily hunting effort and kill. Preseason contacts such as this have been found to significantly reduce the tendency to overestimate harvest after the season has ended (R. L. Kasul, pers. commun.), a phenomenon called "forward telescoping" (Filion 1980). Pride, prestige, and memory failure are among the likely reasons for this postseason overestimation (Atwood 1956). Third, to maximize return for the effort expended, surveys could be expanded to include other game species as well as to provide information on harvest distribution among management zones (Steffen 1981).

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