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INTRODUCTION

Estimation of the legal harvest of various species of game animals is an essential feature of any system wherein an attempt is made to "manage" the species as a recreational asset. While there is an increasing interest in esthetic values of wild animals, the major emphasis of agencies responsible for "game management" remains that of achieving a maximum sustained harvest of certain species by sportsmen. A number of methods have been, and are now, used to attempt measurement of game kill. Two general categories of such methods may be listed; those dependent on field contact of sportsmen during the hunting seasons, and those requiring contact after the season, either by mail or by personal interview. The former methods suffer greatly from a number of difficult sampling problems, not the least of which is the high cost per unit of game tallied. The latter methods necessarily depend on the sportsman's recollection of his hunting experiences, and the proverbial stories about fishermen and fishing illustrate the difficulty there.

Michigan game kill estimates are derived principally from sample surveys, by mail, of licensed hunters. Prior to the early 1950's, we depended on a so-called "report card" system, under which forms were issued with the hunting licenses, presumably to be returned after the end of the hunting season. A principal purpose of this paper is to describe some of the Michigan survey methods and results.

METHODS

Nearly all of our surveys have employed doublereturn postcards. While the size of such cards imposes a severe restriction on the amount of information that can be obtained, this drawback is considerably offset by the low costs, ease in handling, and high rate of responses. Samples of the questionnaire forms and accompanying texts are appended to this paper. As many as four reminder messages are used to insure high response rates, and each such reminder carries the original questionnaire. Different texts are used, of course, and the last two reminders are multilithed letters. We maintain a running quality check on incoming responses, and write back to the respondent (usually with a form letter) if any of several key items is omitted, or answered ambiguously.

Some six or seven separate surveys are conducted each year, covering each of several different kinds of license (i.e., big game, small game, archery, trapping), sub-populations of hunters (as those receiving a special permit to take antlerless deer), or asking for different kinds of information.

Systematic samples (with random starts) are taken from files of carbon copies of the hunting licenses. These files are maintained in a central office (Lansing) but the licenses are sold by some 4,000 issuing agents (largely merchants) throughout the state. A certain number, perhaps 5 per cent, of all licenses sold are not available for sampling, since we must begin our last mailing cycle before the last few returns from issuing agents reach Lansing. Sales of the different licenses range from a few thousand to nearly three-quarters of a million (small game), and total well over one million. The aggregate of all samples runs in the neighborhood of 25,000 individual licensees each year. In one year (1954) we used cluster sampling with individual issuing agents serving as primary sampling units. Some savings in time necessary to complete the surveys were effected, as we were able to obtain samples a good deal earlier in the year than under ordinary circumstances, but costs were considerably increased, and this and other complications made it seem advisable to return to the systematic sampling of central files.

Tabulation and estimation from the survey returns are generally relatively straightforward procedures and will not be described here, except to note that they center around the estimation of total game killed and hunting effort expended.



Figure I. Survey response rates.

RESPONSE RATES

The overall response rates for our eight years of experience with these surveys (1952-1959) have, almost without exception, been over 90 per cent. Results for the three largest annual samples (Figure 1) illustrate the general situation. The two largest samples (regular and special deer) receive identical cards, but differ in that the "special" deer survey is a sampling of persons who apply for and receive a special permit entitling them to take an antlerless deer (the basic Michigan deer hunting season is for antlered male deer only). These persons must submit an application, by mail, to Lansing, so that the return addresses are necessarily better than most such files. Also, the applications are submitted in October and are immediately processed (as part of a random drawing since quotas of permits are regularly surpassed by the applications) and returned. We thus have a complete file at the beginning of the deer hunting season (November) and are able to mail questionnaires at the close of the season, rather than one or more months later as is necessary in the other surveys. All such applicants must, however, have a regular deer hunting license, and thus constitute a subpopulation of the deer hunting licensees. In recent years, from one-quarter to one-half of all deer licensees have applied for permits.



Figure 2. Cumulative response rates by mailing.

Cumulative percentage returns, when graphed by mailing (Figure 2), show necessarily much the same patterns as do the overall rates (Figure 1), but an interesting feature is the low initial return rates for the small game survey. The repeated reminders are effective, and successfully raise an initial moderate return to quite a respectable final tally. We aim at a two-weeks interval between mailings, but actually average somewhat more than that, usually 15 to 17 days. Examination of daily return rates by mailing (Figure 3), here computed on the basis of cards outstanding at the time each mailing becomes effective, shows that we probably might use a shorter interval (only the first 10 days' returns for each wave are shown in the figure). We operate with a rather small staff, however, and since we may have as many as a dozen distinct lots of cards in the mails at once, the two-weeks interval is virtually necessary to spread the work load. It seems, from Figure 3, that there is a decline in efficiency in the successive mailings, but that the general pattern is much the same. Occasionally, administrative deadlines have precluded the fifth mailing, and on one occasion, we did try a sixth mailing. This instance was the 1958 "special" deer survey, and the results were that, out of 6,707 cards initially mailed, we were able to get replies on all but 27; 8 of these were not delivered, and 19 persons failed to respond after six mailings.



Figure 3. Response rates by mailing-1958 surveys.

We have not been able to investigate the reasons for these high response rates in any detail. The questionnaire forms are relatively simple, requiring from a few minutes to perhaps a half an hour or more to fill out, depending on how carefully one searches one's memory for the various items requested. As mentioned above, the two deer-survey cards are identical, and a major difference is one of timing--one card comes out immediately after the hunting season, and the other from one to three months later. Michigan small game seasons range up to nearly five months duration, with many hunters doing most of their hunting in the first month or so, so that there may be a four months or more lag between the performance and the request to recall details. We suspect that this delay, and a rather more cluttered questionnaire, may be largely responsible for the lower small game survey response rates. There is also a suspicion that the average deer hunter takes his sport rather more seriously, and is more of a regular patron than is the small game hunter, who may buy a license on the spur of the moment.

Black, green, and red inks (in that order) are used on the first three cards sent out, and the last two are accompanied by a multilithed letter. Texts of the messages are kept simple, and stress the possibility that the individual may have forgotten, or mislaid his card, as well as various attempts to make the recipient feel that his reply is essential to future hunting prospects, and so on. Since the several texts, and questionnaire forms worked out so well in the beginning, we have been hesitant to make any major changes in the interim, and unhappily, have had no opportunity for any deliberate experimentation (using oddand even-numbered cards of different format, etc.). Perhaps the only definite improvement over the first few years' operation, insofar as increasing response rates go, is an increased reliance on a file of telephone directories and city street maps for piecing out faulty addresses. Perhaps it should be parenthetically noted here, that we do have a rigid rule about substitutionsnone are permitted! A very few (about 1 in 1,000) licenses are so incompletely filled out that they are discarded at the outset. Cards returned by the post office as non-deliverable are checked back to the original license-carbon and remailed, with any improvement of address that seems reasonable. At present, after one try, we relegate such cards to the "dead" file. In the past, repeated mailings to the same address would occasionally be successful, and broadcast mailings to variants on the address sometimes pay off (also, a letter apparently commands more respect in some post offices than do the cards), but our general feeling now is that these several devices do not increase the response rates enough to justify the drag they exert on our limited work-force and facilities.

We suspect that our high response rates may hinge partially on a high interest on the part of those receiving the cards. On the other hand, there is ample evidence that many license-buyers have practically never heard of the Department of Conservation, and two samplings have shown that about one-fifth of the small game hunters do not buy licenses in two successive years. Furthermore, there exists a variety of experience to show that a fair share of deer hunters, at least, are by no means wholly in accord with Conservation Department policies. As an example, we have, for some six years now, conducted a mail sampling (using postcards) of deer hunters in which we ask for various opinions. By far the most controversial issue has been that of whether or not the hunting of antlerless deer (does and fawns) should be permitted. In recent years there has been a steady sequence of legislative bills (and two Acts), public hearings, and an occasional attempt at "cease and desist" injunctions in the courts concerning this matter. Our survey results have indicated a shift from about an even split of opinion, to currently about 60 per cent of deer hunters favoring such seasons. Respone rates on surveys including questions on these seasons have, however, been very much the same as in other, less controversial inquiries.

Gray (1957, 1959), describing quite similar response rates in two surveys conducted in England, ascribes the high rates obtained there to the simplicity of questionnaire forms. We are inclined to agree that this may well be the case, but have only one instance of the use of a longer questionnaire for contrast with our postcard results. In this case, eleven questions (covering two 8¹/₂" x 11" pages), concerning both hunting experiences and opinions about types of deer hunting seasons, were asked of a sample of 1,139 deer hunters. Three mailings resulted in just over a 90 per cent return, which is about that experienced with deer hunters on the "regular" deer surveys. Sampling was, however, restricted to two particular segments of the state (of about county size) through use of a field sampling to obtain license numbers ("backtags" carrying these numbers are required in Michigan). Probably these areas have more than the average numbers of downstate hunters.

A further point of some interest here is that a legislative act (1937) does require hunters to report the game that they bag. The act has never been enforced, and, during the years when reply cards were furnished with the licenses, returns fell off to less than 20 per cent for deer (included in Figure 6), and 5 per cent or so for small game hunters. The act was amended in 1957, and now requires hunters to report only when specifically asked to do so. We doubt that this situation now has any major influence on our response rates, and very likely only a small percentage of all hunters know that such a law ever existed.

EFFECTS OF NON-RESPONSE

There seems to be a distinct tendency for those deer hunters who are successful in bagging a deer (Michigan law permits a hunter to take only one deer in one year) to be more inclined to reply on the first mailing (Figure 4). The average bag per hunter for other species does not, however, show such a distinct difference between returns from first and subsequent mailings. In most cases, there is a definite tendency for the later responses to have somewhat lower average bags, much as shown for pheasants (Figure 4). Cottontail rabbits constitute something of a special case, as we ordinarily must begin the surveys before the end of the long



Figure 4. Reported hunting success by mailing from which response was received.

hunting season on rabbits.

In the reporting system used prior to 1952, each licensee was provided with a report form, but the only follow-ups were various press releases. Rather high initial return-rates (about 70 per cent for deer licensees, and 40 per cent for small-game licenses) soon dropped off (to about 20 per cent for deer and 10 per cent for small-game licensees). In the case of deer hunters an unusual circumstance permits approximate calculation of return-rates for successful (those killing a deer) and unsuccessful hunters. A little more than half of those hunting for deer in Michigan's Upper Peninsula live in southern areas of the state, and virtually all of these hunters return home via the Straits of Mackinac (by car-ferry until 1957, when a bridge connecting the two peninsulas was completed). Since 1921 persons collecting crossing-tolls at the Straits have kept a tally of deer brought across the Straits. We have thus been able to compute an expected number of deer brought across the Straits and compare it with these actual tallies. This ratio of "computed to actual kills" (Figure 5) increased steadily as the proportion of hunters returning their report cards dropped off.



Figure 5. Ratio computed to actual kill as recorded at Straits of Mackinac.

If the bias exhibited at the Straits is considered to be that applying to state-wide estimates, the relative rates of returns shown in Figure 6 may then be computed.



Figure 6. Return rates for report cards.

The previously mentioned tallies of deer brought across the Straits of Mackinac have averaged some 15 to 20 per cent less than estimates of such crossings formed from the mail survey data. In 1957 and 1958 we made sample counts at toll booths, thus obtaining a third estimate of the number of deer brought across the Straits. Results for the two years are:

Year	Source	Estimate	Proportion of mail survey fig.
1957	Toll booth count	9,224	.771
	Mail survey est.	11,960	1.000
1958	Toll booth count	12,830	.857
	Sample-count est.	13,962	.932
	Mail survey est.	14,972	1.000

The sample counts were designed for ratio estimation, using tallies of vehicles crossing the Straits as an auxiliary variate (mechanical counts are made of vehicular traffic). Unfortunately, since precise estimates of uni-directional traffic flow were not available for the first sampling (1957), only the 1958 estimate is based on the ratio method. Variance estimates have not yet been made for the two samplings, but it seems certain that rather high precision was obtained. It appears, then, that the mail survey estimates are fairly well substantiated by the above data.

We have had several other, but less satisfactory, opportunities to check mail survey estimates of deer kill against supposedly complete tallies. These include records kept on car-ferries which service three islands (of 55 to 130 square-miles in area) and mandatory "registration" of antlerless deer shot during two hunting seasons on an area of about 1,000 square miles. In all such cases the mail survey estimates have been very nearly those of the other sources.

Hunter reports as to the kind of deer taken are an entirely different matter, however. Here we find that many hunters either cannot distinguish between adult females and juveniles (fawns) of both sexes, or do not wish to report shooting small or antlerless deer. We have consequently been forced to depend on data collected at highway checking stations to estimate sex and age composition of the deer harvest.

Precise checks on the validity of kill reports for other species are lacking. An occasional accidental duplication of returns, and a limited amount of deliberate checking for a few species, suggest that hunters do make various mistakes or report inaccurately. Atwood (1956) has reported on an extensive study of various presumed biases in reporting the kill of waterfowl. We have found a very close correlation (MacMullan, 1960) between the estimated hunting kill of pheasants and an entirely independent index to population density, suggesting that the kill estimates are at least consistent.

SURVEY COSTS

Not counting charges for office space or equipment depreciation, our costs are roughly 50 cents per completed response. Since our office facilities are multi-purpose, it is difficult to assign a specific item of cost. From 3 to 5 seasonal (6 to 9 months of the year) clerks and one fulltime supervisor work on the surveys, and no special equipment beyond the usual office facilities is used, excepting IBM equipment, but this is included in the cost figures. We have attempted to include all other items of cost in the overall computation, including such things as editing and coding of responses, and preparation of routine final reports.

In our rather small operation, we find that overall costs will vary appreciably with the quality of clerical help available in a particular year. Also, some of the surveys require an appreciable amount of coding and cross-tabulation, and various collating procedures have been necessary to avoid duplication or sort out a special subpopulation in some cases. We have, however, little difficult editing, outside of the determination of locations where deer are reported killed, which does require someone rather intimately acquainted with the northern areas of the state, and this ordinarily precludes use of clerical personnel for the job. Two other "extra" items of cost perhaps should be mentioned. We find that attempts to whittle down the existing 3 per cent or so of "non-deliverable" cards by various sorts of detective work can be rather expensive, and from 5 to 10 per cent of our approximately 25,000 responses require further contacts (by letter) to attempt to get some essential item omitted from the first response.

In general, our costs range from about 30 cents per response for the simpler questionnaires requiring only straightforward coding and tabulations to as much as 60 to 70 cents for more complex questionnaires having fairly elaborate coding and tabulation (it also happens that one such survey has the lowest initial response, and thus higher costs). These are all postcard questionnaires, although the last two or three reminders may be sent out with form letters. All materials used in the survey are multilithed in a state-owned facility, and, while we have included an approximate cost figure for such services, the limited volumes used in our surveys would likely be a good deal more expensive on a commercial, job-lot basis.

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QUESTIONNAIRE FORM

NOV. COUNTY NUNTED	DEER AND BEAR SURVEY- 1959
Sun. 15 Mon. 16 Tue. 17 Wed. 18 Thu. 19 Fri. 20 Sat. 21 Sun. 22	 Did you hunt this past deer season? Yes
Non. 23 Tue. 24 Wed. 25 Thu. 26 Set. 28 Sun. 29 Mon. 30	6. What kind was it? Buck □ Buck Peem □ Doe Doe Peem □ DID YOU GET A BEAR? YesNo If you got a bear, where was it killed?

TEXT OF FIRST MAILING

Mr. Deer Hunter:

You have been selected as a representative door hunter to help us secure an accurate appraisal of the recent deer season. Your observations and experiences added to many others will give us very important information.

Please note that this survey also includes bear hunting. If you hunted for bear after killing your deer, include the counties and dates. (You do not need to indicate whether you were hunting bear or deer.)

Please fill out the card and drop it in the mail TODAY.

Thank you,

GAME DIVISION Michigan Department of Conservation

TEXT OF SECOND MAILING

FIRST REMINDER

Some time ago you were asked to supply certain information to the Conservation Department's Game Division.

You probably had good intentions of mailing the return card but simply forgot it or perhaps mislaid the card. Don't forget that we work for you and that the information you give us is very necessary for the proper management of your deer herd.

We will probably continue to bother you if we don't hear from you soon. So please fill in the attached card and mail it right away.

Thanks,

GAME DIVISION Michigan Department of Conservation QUESTIONNAIRE FORM

SMALL GAVE SURVEY 1959-1960														
PLEASE CHECK THIS ANIMALL					RUNYES IN MORE THAN ONE COUNTY, USE A SEPARATE Column for each county you musted in.									
VES OR NO AFTER EACH ANIMAL	ve		664877 444769	NO. DAVE	E 111'E0	604877 Husted	4348.0H	80. 811160	60 WW T T Num T E D	80. 0AV8		COUNTY HUNTED	43 A 808	
PHEASANTS														
190960CE														
DU CE S														
98898														
COTTONTAIL BABBITS														
SNOTSHOE MARES														
DID YOU BUY DE	ER I	LICE	HSES LAST	FAL	1.7			YES		AR	CHER	Y : YES]	0	ר

TEXT OF FIRST MAILING

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ill you t immedi It i	please help us by filling out the attached post card and mailing ately? s important that you follow these directions exactly:
(1)	Nead over the list of game and indicate whether or not you hunted each kind by CHECKING "YES" OR "NO" AFTER EACH ANIMAL.
(2)	After each kind hunted write in the COUNTY or COUNTIES IN WHICH YOU HUNTED and give the total number you killed in each county. Put in ZENO if you didn't kill any. (If you don't know the county, the name of the nearest toom will do.) Also give the number of days you hunted in each county.
	Thank ýœ,
	GAME DIVISION Michigan Department of Conceptation

TEXT OF SECOND MAILING

FIRST REMINDER

Dear Sir:

Some time ago we sent you a card asking about your small game bunting success last season. Your answers provide very important information, so please send in the attached card today.

It is important that you follow these directions exactly:

- (1) Read over the list of game and indicate whether or not you hunted each kind by CHECKING "YES" OR "NO" AFTER EACH ANIMAL.
- (2) After each kind hunted write in the COUNTY or COUNTIES IN UNICE YOU MUNTED and give the total number yes killed in each county. Put in ZEMO if yes didn't kill any. (If yes den't mow the county, the name of the searcat term (il do.) Also give the number of days you hunted in each county.

Thank you, GAME DIVISION Michigan Department of Conservation