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Influence of advanced notice record cards on waterfowl hunting participation and harvest distributions

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ABSTRACT

Wildlife management often requires accurate estimates of hunter participation and species harvested. Sending pre-season hunting cards for recording activity can improve the accuracy of estimates. This research note examined the influence of record cards on the shape of waterfowl hunting survey response distributions. Data were obtained from a 2013–2014 mail survey of 1,796 waterfowl hunters in Illinois. Results indicated that individuals who received a record card were: (a) more likely to report small harvest and days hunting values (beginning of distribution), and (b) less likely to give responses that contributed to heaping (middle of distribution) compared to non-record card recipients. Record cards did not influence the end of the distribution, as frequency functions for all respondents were long-tailed distributions. Results imply that record card responses are more accurate than non-record card responses. Non-record card estimates were approximately 10% biased. Results supported continued use of record cards to limit bias.

KEYWORDS

Harvest surveys; heaping; long-tailed distributions; record cards; waterfowl

Introduction

Wildlife management in most countries requires accurate estimates of hunter participation and harvest. Waterfowl harvest estimates, for example, are important to both state agencies and the U.S. Fish and Wildlife Service for setting daily bag limits. Annual harvest estimates are provided at state, flyway, and national levels (U.S. Fish and Wildlife Service, 2016). Harvest estimates, however, can vary widely by species. For example, big game (e.g., deer, elk, moose) hunters are likely to report accurately, as recall bias is not a factor because few animals, if any, are harvested and seasons are short (Schmidt & Chapin, 2014). For small game (e.g., waterfowl, quail, dove, rabbit), for which the season is relatively long and the harvest is potentially large, estimates are prone to recall bias (Beaman, Vaske, & Miller, 2005a; Miller & Anderson, 2002; Vaske & Beaman, 2006).

Surveys are commonly used for collecting data and estimating harvest. When asked to recall a quantity (e.g., game bagged) or frequency (e.g., days of hunting participation), respondents may employ a variety of cognitive processes (Beaman, Vaske, & Miller, 2005b; Huttenlocher, Hedges, & Bradburn, 1990). For example, traditional memory models assume that people answer the questions using episode enumeration (Sudman, Bradburn, & Schwarz., 1996). Specific episodes are recalled from memory for the relevant time frame, counted, and

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a response is given. Response errors in these situations occur when individuals fail to recall specific events (episode omission) and/or misplace the episode in time (telescoping).

As frequency of participation in a behavior and/or quantity to be estimated increases, episodic enumeration can give way to other cognitive processes (Burton & Blair, 1991). For example, respondents may use estimation heuristics where frequency is estimated by recalling sample episodes (Tversky & Kahneman, 1974). More salient episodes are more likely to be recalled, resulting in overestimation (Vaske, Huan, & Beaman, 2003).

The recall process may also involve the use of prototypes. A prototype is defined as a single number that is taken to characterize a set or range of values (Reed, 1996). For example, a person may recall hunting somewhere between eight and 12 times per month. If asked about frequency of hunting, the prototype used in a survey response might be 10. A respondent may see this as the best response because it is central to the interval of eight to 12.

Approximate responses, such as prototype responses, are suggested by response heaps (i.e., peaks in response frequency functions). Heaps appear because some responses are given more often than would be expected by chance (Chase & Harada, 1984; Hultsman, Hultsman, & Black, 1989). Giving approximate responses, answering with prototype responses, such as numbers ending in zero or five, potentially distorts findings (Connelly & Brown, 1992; Hiett & Worrall, 1977). If responses are systematically in error (biased), the utility of estimates for planning and management may be compromised.

Research has shown that survey methods can influence response heaping and related bias (Vaske & Beaman, 2006). For example, shortening the recall period (e.g., a few months vs. an entire year) for which respondents are asked to report estimates of behavior tends to reduce bias (Beaman, Vaske, Donnelly, & Manfredo, 1997; Chu et al., 1992; Tarrant & Manfredo, 1993; Vaske, Beaman, Manfredo, Covey, & Knox, 1996). Bias increases when respondents are asked to recall events over long periods. Merits of a reduced recall frame, however, depend on the activity under investigation. As noted above, big game hunters who are asked to recall the harvest of an animal last year are likely to report relatively accurately. Few animals are usually harvested, so the number can be easy to remember. However, those who hunt the same species (e.g., mallards) for multiple weeks may not be certain about days hunted or number harvested.

Sending hunting activity record cards prior to a hunting season has been recommended for reducing response heaps and improving the accuracy of harvest and participation estimates derived from survey responses (Beaman, 2002). Miller and Anderson (2002), for example, sent half of the hunters in their sample a record card for logging their hunting activities (e.g., days spent hunting, harvest on those days) prior to the start of the season. The other half of hunters in their sample did not receive the record card. Results indicated that hunters who received the record card were less likely to provide answers that ended in zero or five (i.e., less likely to give prototype responses). Additional analyses of the same data (Beaman et al., 2005b), however, demonstrated that although record card recipients exhibited less zero to five heaping, prototype responses explained less than 20% of the difference in means for participation and harvest. Differences in estimates were partly a result of record card recipients reporting low days of participation and low harvest compared to non-record card recipients. Record cards prompted more individuals with low days of participation and low harvest to answer the questions.

Miller, Stephenson, and Williams (2015) examined the assumption that pre-season harvest cards influenced reported duck harvests and duck hunting days afield. Harvest cards were sent to a random sample of 5,000 waterfowl stamp purchasers. A second sample of 2,500 stamp purchasers were not mailed harvest record cards. Other than mailing the pre-season harvest record card to the first group, the two groups did not differ. Harvest estimates were calculated for teal, mallards, other duck species harvested, and total days of duck hunting. Results indicated that the two groups did not differ statistically in terms of total days spent duck hunting or reported harvest of teal and mallards. Significant differences were, however, found between the groups for other duck species and total ducks harvested, but the effect sizes were minimal.

The present article examined the influence of record cards on the shape of waterfowl harvest and participation response distributions. A distribution's shape can highlight where bias exists. The variables of interest represent the number of (a) days a person participated in duck hunting, and (b) birds harvested. Such frequency functions have been shown to be skewed with a long tail in the positive direction (Foss, Korshunov, & Zachary, 2011; Moyer & Geissler, 1984, 1991). For hunting, long-tailed distributions have a large number of individuals with low or moderate participation and harvest, and a small number of people with high participation and harvest (Figure 1). Despite the low numbers in the distribution's tail, total days and harvest rates in the tail are relatively large. When 20% of responses with largest values contribute 50% or more to the mean, the distribution is long-tailed (HoggStuart & Klugman, 1983; Kreuter et al., 2004).

Long-tailed distributions can cause estimation problems (Foss et al., 2011; Huan, Beaman, Chang, & Hsu, 2008). Even with a relatively small percentage of responses in a distribution's tail, means and variances can increase dramatically (Brown & Tukey, 1946). Large additions to the variance arising from responses in a distribution's tail can result in no statistically significant differences in mean responses between record card and non-record card recipients (Beaman et al., 2005b). Similarly, Vaske (2008) asked mail survey and telephone survey respondents to estimate the amount of money they had spent

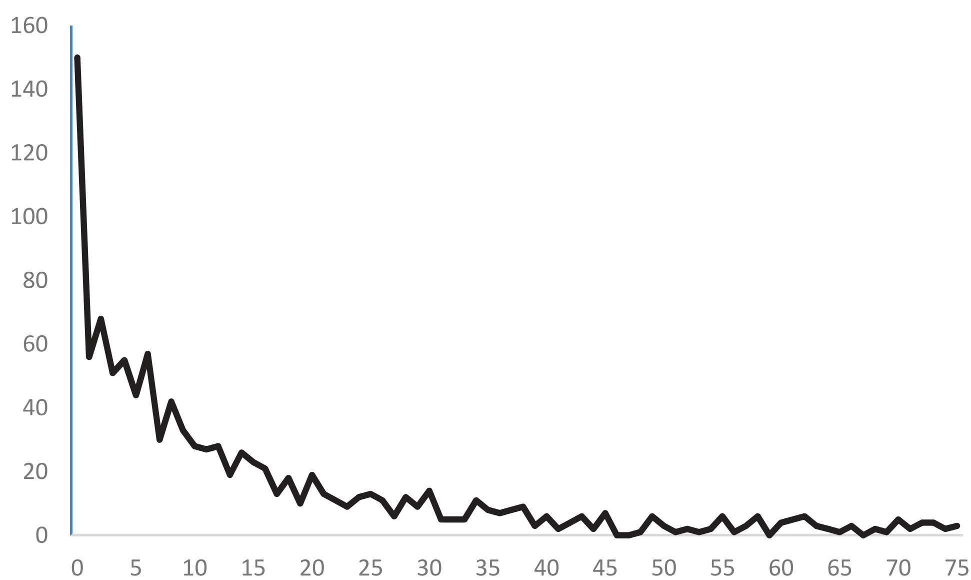

Figure 1. Example of a long-tailed distribution.

on all recreation equipment. On average, the mail survey recipients spent $4,569, whereas the average for the telephone survey respondents was $6,306. Despite a difference of $1,737, the mean comparison was not statistically significant due to large variances. The size of the variances was attributed to long-tailed distributions.

Overall, research (e.g., Beaman et al., 2005b; Miller & Anderson, 2002; Miller et al., 2015) suggests several considerations. First, non-record card responders tend to under-report small values (i.e., non-record card hunters report greater harvest). This implies a positive bias influence because of the deficit at the low end of the distribution (i.e., data are less accurate when small value responses are replaced by larger ones). Second, non-record card recipients are more likely to give prototype responses (i.e., numbers ending in zero or five), which also tends to result in less accuracy in the middle of the distribution (Beaman et al., 2005a; Miller & Anderson, 2002). Third, long-tailed distributions have declining frequency functions that result in positive bias at the high end of the distribution (see Beaman, Vaske, & Grenier, 1998). Given these considerations, the following hypotheses were advanced and tested in this research note:

H_1: Individuals who received a record card have more responses for small values of days hunting and harvest compared to those who did not receive the card.

H_2: Individuals who received a record card give fewer responses resulting in frequency function heaps in days hunting and harvest compared to those who did not receive the card.

H_3: Frequency distributions for days hunting and harvest are long-tailed distributions.

H_4: Bias in non-record card responses implies mean differences between record card and non-record card respondents are positive and not attributable to chance.

Methods

The Illinois Natural History Survey has conducted annual waterfowl harvest surveys of Illinois hunters since 1981. A random sample of waterfowl stamp purchasers is selected each year and mailed a pre-season harvest record card. Hunters are instructed to record individual duck and goose species harvested, along with the number of days hunted. Following conclusion of all waterfowl hunting seasons in the state, participants are mailed a waterfowl hunter questionnaire. Questionnaire mailings and postcard reminders are mailed in two-week intervals. Questionnaires contain items related to harvest and number of days hunting. Hunters are instructed to use the harvest card when completing the days hunted and harvest portions of the questionnaire.

During the 2013–2014 season, a total of 7,500 hunters were randomly selected for the Illinois Waterfowl Hunter Survey. Pre-season harvest cards were mailed to 5,000 waterfowl stamp purchasers, and 2,500 stamp purchasers were not mailed harvest record cards. Other than mailing the pre-season harvest record card to the first group, the methods for the two groups did not differ; both received the same questionnaires mailed on the same dates. A total of 3,331 (46%) completed questionnaires were returned from both groups. Only respondents who reported duck hunting one or more days (n= 1,796) were included in the analysis.

Data Analysis

Frequency distributions were computed for days of duck hunting and harvest of mallards, other duck species, and total ducks harvested at the state level. Hypothesis one predicted that individuals who received a record card have more responses for small values of days hunting and harvest compared to those who did not receive the card. Small values were defined as less than or equal to four.[1] Hypothesis two predicted that those who received a record card give fewer responses resulting in frequency function heaps in days hunting and harvest compared to those who did not receive the card. Both of these hypotheses were tested with chi-square analyses, with Cramer's *V* as the effect size indicator. A Cramer's *V* of .1 was considered "minimal," .3 was labeled "typical," and .5 was judged "substantial" (Vaske, 2008).

Testing if the frequency distributions were long-tailed was based on the 80th percentile (hypothesis three). A common criterion for a long-tailed distribution is when 80% of respondents contribute ≤50% to the mean (HoggStuart & Klugman, 1983; Kreuter et al., 2004). The test for hypothesis four (i.e. mean differences between record card and non-record card respondents are positive and not attributable to chance) was based on one-tailed independent sample *t*-tests. Point biserial correlations (r_{pb}) were used for indicating the strength of a relationship; .10 was considered a "minimal" relationship, .243 represented a "typical" relationship, and .371 or more reflected a "substantial" relationship (Vaske, 2008).

Results

Hypothesis one predicted that those who received a record card have more responses for small values (i.e., ≤4) of days hunting and harvest compared to those who did not receive the card. For days of duck hunting, small values were one to four because one day of duck hunting was required to be considered a duck hunter. For harvest, small values were zero to four. About one-third (31%) of the record card respondents gave a number between one and four for number of days duck hunting, compared to 26% for the non-record card recipients (Table 1). Fifty-two percent of the record card respondents reported a mallard harvest less than or equal to four, whereas 49% of the non-record card individuals reported a harvest in this range. For total other duck species and total ducks harvested overall, the numbers were 54% and 33%, respectively, for the record card group, and 47% and 28%, respectively, for the non-record card group. All of these differences were statistically significant ($\chi^2 \geq 3.85$, $p \leq .050$ in all cases) and in the predicted direction. These results supported hypothesis one, but the effect sizes were minimal (Cramer's $V \leq .068$ in all cases).

Hypothesis two predicted that individuals who received a record card give fewer responses resulting in frequency function heaps in days hunting and harvest compared to those who did not receive the card. For days of hunting ducks and number of mallards

Table 1. Responses for values ≤4 among Illinois waterfowl hunters (2013–2014).

	Record card %	Non-Record card %	χ^2	*p*-value	Cramer's *V*
Days hunting ducks	31	26	4.62	.032	.055
Ducks harvested					
Mallards	52	49	3.85	.050	.044
Total other species	54	47	8.23	.004	.068
Total ducks harvested	33	28	3.85	.050	.046

Table 2. Percent of responses in 0–5 heaps among Illinois waterfowl hunters (2013–2014).[1]

	Record card %	Non-Record card %	χ^2	*p*-value	Cramer's *V*
Days hunting ducks	35	41	5.71	.017	.057
Mallards harvested	19	25	7.02	.008	.063

1. "Total other species" and "total ducks harvested" are not included in this table because these variables were computed by summing the number of different types of ducks that were harvested.
The summation obscures numbers ending in 0 or 5. For example, if a person harvested five mallards (a 0–5 number) and one teal (a non-0–5 number), the sum equals six and the heap for five mallards is not apparent.

harvested, percentages were in the predicted direction and statistically significant ($\chi^2 \geq 5.71$, $p \leq .017$, Table 2). Both effect sizes were minimal (Cramer's $V \leq .063$). These findings supported the second hypothesis. As an aside, "total other species" and "total ducks harvested" were not included in Table 2 because these variables were computed by summing the number of different types of ducks that were harvested. This summation obscures numbers ending in zero or five. For example, if a person harvested five mallards (a 0–5 number) and one teal (a non-0–5 number), the sum equals six and the heap for five mallards is not apparent.

Hypothesis three predicted that the frequency functions for days hunting and harvest are long-tailed distributions. Table 3 shows the response values associated with the 80th percentiles. As noted earlier, if 80% of respondents contribute ≤50% to the mean, the distribution is long-tailed. For both the record card and non-record card respondents, percentages were consistently ≤50%. For example, for days of duck hunting, 48% of record card recipients and 50% of non-record respondents contributed to the mean. For harvest estimates, the percentages were even lower. Among individuals who received record cards, percentages were 31% (mallards), 28% (total other species), and 36% (total ducks harvested). For non-record card respondents, the comparable percentages were 34%, 31%, and 39%, respectively. Based on responses to the 80th percentile accounting for 50% or less of the mean, all estimates were long-tailed and supported hypothesis three.

Hypothesis four predicted that mean differences between record card and non-record card respondents would be positive and not attributable to chance. Support for this hypothesis is shown in Table 4. For all four variables, differences in means were positive and ranged from 1.06 (days duck hunting) to 2.73 (total ducks harvested). Three of the four *t*-tests showed the differences were statistically significant: days hunting ducks ($t = 1.97$, $p = .037$), total other duck species ($t = 2.23$, $p = .013$), and total ducks harvested ($t = 2.00$, $p = .023$). Mallard harvest differences were in the predicted positive direction ($M = 1.16$), but not statistically significant

Table 3. Long-tailed distributions as reported by Illinois waterfowl hunters (2013–2014).[1]

	Percent of Mean	
	Record card %	Non-Record card %
Days hunting ducks	48	50
Ducks harvested		
Mallards	31	34
Total other species	28	31
Total ducks harvested	36	39

[1]Long-tailed distribution occurs when approximately 80% of respondents contribute ≤50% to the mean.

Table 4. Mean estimates for days duck hunting and harvest by Illinois waterfowl hunters (2013–2014).

	Record card *M*	Non-Record card *M*	Difference in Means	Means Difference %	*t*-value	*p*-value	r_{pb}
Days hunting ducks	12.53	13.59	1.06	9	1.97	.037	.042
Ducks harvested							
Mallards	9.90	11.06	1.16	12	1.45	.074	.034
Total other species	6.62	7.93	1.31	20	2.23	.013	.053
Total ducks harvested	18.66	21.39	2.73	15	2.00	.023	.049

($t = 1.45$, $p = .074$). The impact of these results is evident in the "Means Differences %" column in Table 4. These differences suggest a bias in non-record card recipient responses ranging from 9% percent (days duck hunting) to 20% (total other duck species harvested). All effect sizes, however, were minimal ($r_{pb} \leq .053$).

Discussion

This article examined distributions of the reported waterfowl harvests and participation among hunters who received a pre-season record card and those who did not. Record cards can potentially influence the beginning, middle, and end of the distributions. Non-record card data were positively biased relative to record card data and this bias resulted in relatively large positive percent differences in means.

As predicted, individuals who received a record card were more likely to report small values of days afield and harvest rates compared to those who did not receive the card. Such differences impact estimates of days of participation and harvest, as responses that are less than or equal to four are essentially being replaced by responses that could be much greater. Under-reporting for low values is a cause of positive bias in non-record card estimates of means and totals. The impact of not reporting few days hunted and small harvest rates should be examined further in future research.

Individuals who received a record card gave fewer responses resulting in frequency function heaps compared to those who did not receive the record card. The size of such peaks can have a substantial influence on the means of a distribution. Peaks occurring on frequency functions that are declining implies a positive bias from peaking.

If 80% of respondents contribute 50% or less to the mean, the distribution is long-tailed. For both samples of respondents (i.e., record card and non-record card), all percentages were consistently ≤50% for days afield and harvest estimates. The difference between the days hunting estimates (48% and 50%) and harvest estimates (28% to 39%) likely occurred because season dates limit participation and estimated number of days; the upper bound was 60 days during the 2013–2014 season. Harvest estimates, however, are not as constrained because hunters can bag up to six birds per day.

The bias associated with non-record card responses implies mean differences between record card and non-record card respondents for days afield and harvest rates are positive and not attributable to chance. The percent means difference (9% [days duck hunting], 12% [mallard harvest], 20% [total other ducks], 15% [total ducks harvested]) suggested that not using record cards introduces potentially serious bias in the estimates. Although all effect sizes were minimal, the size of these bias estimates suggests that they should not be ignored. Ancillary analyses of a similar 1999 waterfowl survey in Illinois (Miller, Campbell, & Yeagle, 2000) that also included record card and non-record card respondents revealed an identical pattern of findings to those reported here. Given the consistency of these findings and resulting biases in the data, identifying ways to distribute the record cards in a cost-effective manner becomes an important management consideration.

Determining accurate game harvests is an essential component of wildlife management in many countries. This is especially true for species such as migratory birds where the harvest estimate can be large. Waterfowl management plans, at both the state and federal levels, are dependent on accurate harvest data. For example, the Adaptive Harvest Management protocol uses models based on three mallard populations (U.S. Fish and Wildlife Service, 2016). This model includes mallard harvests as parameters, and accurate harvest estimates are critical for meaningful estimates. Similarly, individual states conduct waterfowl harvest surveys and depend on accurate data for state management programs. If differing data collection methods result in differences in estimates as suggested in this research note, then estimates may vary substantially for certain species. It is important to understand the effects of harvest distributions on harvest estimates to provide managers with the greatest accuracy possible.

Note

1. Four were selected because five is a prototype number.

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