and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand, or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.
Digit preference is a form of response error whereby individuals report behaviors such as days of participation in numbers ending in zero or five. Keeping seasonal records may decrease digit preference and provide more accurate records of recreationists’ behaviors. This study tested the effect of providing a preseason harvest card for recording harvest during the season in reducing digit preference among waterfowl hunters in Illinois. Reported mallard duck (Anas platyrhyncus) harvests were tested for individual digit preference (IDP) and aggregate digit preference (ADP). Individual digit preference among the harvest card group approximated the expected probability (22%), whereas the group with no harvest card exhibited IDP of 31%, which is a significant difference. Aggregate digit preference was 9% for the harvest card group and 18% for the group without harvest cards. Given the level of digit preference, it may have an impact on wildlife harvest estimates based on self-reported counts provided via mail surveys. This study supports previous work that suggests record-keeping on the part of recreation participants provides a means to decrease harvest estimate digit preference.

Keywords aggregate digit preference, individual digit preference, hunter harvest, reporting error, waterfowl hunters

Introduction

Researchers have long recognized the influence of recall error in estimating recreation participation (Hammitt & McDonald, 1982; Tarrant & Manfredo, 1993). Recall error can be manifested as omission, telescoping, or digit preference (Chu, Eisenhower, Hay, Morganstein, Neter, & Waksburg, 1992). Omission generally occurs when respondents fail to recall and report an event or underreport the num-

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Address correspondence to Craig A. Miller, Illinois Natural History Survey, 607 E. Peabody Dr., Champaign, IL 61820, USA. E-mail: craigm@inhs.uiuc.edu
ber of times an event occurred. Telescoping refers to individuals reporting events closer to the present than they actually occurred. Digit preference has been defined as responses favoring digits ending in 0 or 5 (Pickering, 1992; Vaske, Beaman, Manfredo, & Covey, 1996; Wen, Kramer, Hoey, Hanley, & Usher, 1993). The study examines the prevalence of digit preference in self-reported harvest of waterfowl among hunters and to investigate the effect of harvest records on digit preference.

Research on digit preference in recreation has focused primarily on self-reported levels of participation. Several studies suggest digit preference is more apparent among individuals with higher levels of participation in a particular activity (Chase & Godby, 1983; Chu et al., 1992). Swimming and tennis club members who swam or visited a tennis club at higher frequencies were more likely to report participation in numbers ending in 0 or 5 (Chase & Godby, 1983; Chase & Harada, 1984). Chu et al. (1992) reported that avid anglers exhibited digit preference more often than anglers who fished infrequently. A study of Illinois anglers by Tarrant and Manfredo (1993) found digit preference for days fished interacted with nonresponse bias and recall error. Their study concluded that digit preference may explain errors previously attributed to recall and nonresponse. In a study of Colorado anglers, digit preference was found to be related to recall frame and response strategy used by anglers reporting days fished (Vaske et al. 1996). Digit preference increased for individuals who did not keep records of their angling trips.

The study conducted by Chu et al. (1992) showed that hunters exhibited less tendency for digit preference compared to anglers, possibly due to different hunting seasons allowing for discrete units of recall relative to fishing. Hunters in a lottery hunt in Indiana showed digit preference in self-reported days and years hunted (Hultzman, Hultzman, & Black, 1990).

One aspect of digit preference that has not received widespread attention is self-reported harvest for game species. Many states rely on mail surveys to estimate harvests of various wildlife species. Such estimates are important in population models and to establish future harvest quotas. For example, the Adaptive Harvest Management model used by the U.S. Fish and Wildlife Service to manage waterfowl depends on hunters’ reports of duck and goose harvests, which are used to estimate state, flyway, and national harvests. The states, flyways, and U.S. Fish and Wildlife Service then use these estimates for making decisions regarding waterfowl management.

Recall error and nonresponse bias in harvest surveys has been suggested as the source of error in self-reports of waterfowl harvest (Barker, 1991; Barker, Geissler, & Hoover, 1992; Wright, 1978). Investigators were beginning to question recall error in waterfowl hunter surveys as early as the 1950s (Atwood, 1956). In a study of Canadian waterfowl hunters, Sen (1973) found hunters tended to round upward in reporting the number of waterfowl harvested. Overestimations in seasonal bag and number of trips taken were common among Iowa waterfowl
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Digit preference (IDP). The determination of IDP is thus the ratio of responses ending in 0 or 5 to total responses:

\[ \text{IDP}_{0 \text{ or } 5} = \frac{\sum (\text{Observed responses ending in } 0 \text{ or } 5)}{\text{Total responses}} \]  \hspace{1cm} \text{Definition 1}

Using definition 1, the proportion of individuals in a population exhibiting DP (IDP$_{0 \text{or } 5}$) on a given variable (e.g., participation rate in fishing or hunting) equals the proportion of individuals whose responses on that variable end in 0 or 5 (Beaman et al., 1997).

They suggest removing the bias of IDP by measuring digit preference based on the aggregate numbers (on the observed frequency function for 0–5) of responses exhibiting digit preference divided by total responses. Thus:

\[ \text{ADP}_{0 \text{ or } 5} = \frac{\text{Estimated number exhibiting DP}}{\text{Total responses}} = \frac{\sum (\text{Observed frequencies} - \text{Estimated number not exhibiting DP})}{\text{Total responses}} \]  \hspace{1cm} \text{Definition 2}

where the sum equals all responses ending in 0 or 5 if the sum of the residuals > 0. If the sum of residuals is < 0:

\[ \text{ADP}_{0 \text{ or } 5} = 0 \]

When DP is present, the numerator for the equation in Definition 2 will be greater than 0.

\[ \sum (\text{Observed frequencies} - \text{Estimated number not exhibiting DP}) > 0 \]

If DP is not present, the sum of the observed frequencies minus responses not exhibiting DP can be negative. Therefore, a high probability exists that the resulting average of the residuals will be negative:

\[ \sum (\text{Observed frequencies} - \text{Estimated number not exhibiting DP}) < 0, \]
where the observed frequencies are the sum of each reported value ending in 0 or 5, and estimated number not exhibiting DP are the means of the sum for reported two values preceding and following each digit ending in 0 or 5. The residuals thus produced are summed and divided by total responses. Based on its definition, aggregate digit preference (ADP) is an unbiased estimator of the occurrence of digit preference among responses in that it is 0 if there is no digit preference.

The studies reported here mainly discuss digit preference as a function of recall error that increases with increased participation. Does this same phenomenon of digit preference also occur in self-reports of harvest by hunters? Recognizing the bias in the definition of digit preference as discussed by Beaman et al. (1997), is there a difference in IDP and ADP in reported harvests among hunters who receive a preseason harvest record versus those that do not?

The purpose of this study was to expand on previous research investigating the use of records in response strategy and to examine the corresponding effect on digit preference in self-administered mail questionnaires (Vaske, Beaman, Manfredo, & Covey, 1996). Furthermore, this study intended to provide an empirical comparison of individual digit preference to aggregate digit preference in harvest estimates. Specific objectives were to: 1) investigate the occurrence of individual digit preference and aggregate digit preference in a self-reported waterfowl harvest survey, and 2) examine the effect of a season-long harvest record in reducing aggregate digit preference. To this end, the following hypothesis was proposed:

H1: Individual digit and aggregate digit preference occurs with greater frequency among hunters who rely on memory to estimate harvest than hunters who record harvests throughout the season.

Methods

Data for this study were generated through the 1999–2000 Illinois Waterfowl Hunter Survey, an annual self-administered mail survey conducted to determine statewide waterfowl harvest and hunter activities. A random sample of 4,748 hunters was selected from the estimated 55,000 resident waterfowl hunters in Illinois. The sample was divided into two groups of approximately the same size. One group of 2,388 hunters was mailed a harvest record card during August 1999, prior to the start of the 1999–2000 waterfowl season. These hunters were asked to record daily harvest by species, date, and county hunted. The accompanying cover letter stated that they would receive a mail survey questionnaire following the close of the season for reporting their days afield and harvest during 1999–2000 waterfowl season. The letter requested hunters keep accurate accounts of their hunts on the harvest record card and use this information to complete the harvest portion of the survey questionnaire. The remaining 2,360 hunters in the sample received no harvest card and were not notified that they were selected for the
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Completed questionnaires were received from 1,717 (72%) hunters who received the preseason harvest record card. A total of 1,430 (61%) completed questionnaires were received from the 2,360 hunters who were not mailed a harvest record card (Table 1).

Of the 3,147 waterfowl hunters surveyed, 1,924 (61%) reported harvesting waterfowl hunter survey.

All hunters in the sample were mailed an 8-page, self-administered mail survey questionnaire during February 2000, following the conclusion of the 1999–2000 waterfowl hunting season. The first part of this questionnaire asked hunters to provide counties hunted, total days afield, and harvest for several species of ducks: mallard, wood duck, teal, canvasback, and other ducks. The cover letter accompanying the questionnaire for the subsample that had received the preseason harvest card reminded them to use the information on this card to complete the days afield and harvest portion of the questionnaire. The first mailing of the questionnaire was followed 2 weeks later with a postcard reminder to nonrespondents. A second mailing of the questionnaire and cover letter was mailed to nonrespondents 2 weeks after the first postcard, and was followed 2 weeks later with a postcard reminder to nonrespondents.

In order to receive a response uninfluenced by research design and to avoid prompting hunters in the harvest card group to use their cards if they had forgotten or not planned to do so, hunters were not questioned on the survey questionnaire as to how they arrived at their harvest estimate. Instead, a follow-up telephone survey was conducted to determine how hunters arrived at reported harvests. A random sample of 250 successful hunters (130 from the harvest card group and 120 from the no-harvest card group) who responded to the survey were called and asked to identify how they estimated their harvest: kept records, estimated harvest, or recalled from memory. Hunters in the harvest card group were also asked if they used the harvest card provided by the Illinois Department of Natural Resources prior to the season.

Mallard duck (*Anas platyrhyncus*) harvest was selected to test harvest record effect on harvest reporting manifested as digit preference. Mallard harvest was chosen because this species constituted the largest proportion of the waterfowl harvest and was harvested more frequently by hunters statewide than other duck species. Daily limit of mallards during the 1998 season in Illinois was four birds. Individual digit preference was coded as 1 for harvest totals (of 1 or more ducks) ending in 0 or 5, and 0 for all other numbers. Hunters who did not harvest any birds (and thus had 0 for harvest) were not included in the analyses. IDP for the two groups was determined using Pearson’s chi-square analysis on a 2 × 2 contingency table. Significant difference of ADP between the two groups was tested using student’s *t*-test for two independent samples.
TABLE 1  Response from Waterfowl Hunters with and Without Preseason Harvest Record

<table>
<thead>
<tr>
<th>Test group</th>
<th>n</th>
<th>Response</th>
<th>Percent of total responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preseason harvest record</td>
<td>2,388</td>
<td>1,717 (72%)</td>
<td>55%</td>
</tr>
<tr>
<td>No preseason harvest record</td>
<td>2,360</td>
<td>1,430 (61%)</td>
<td>45%</td>
</tr>
<tr>
<td>Total</td>
<td>4,748</td>
<td>3,147 (66%)</td>
<td></td>
</tr>
</tbody>
</table>

one or more mallards during the 1999–2000 season. A slightly lower proportion of successful hunters were among the preseason harvest record card group than the no harvest card group: 1,306 (60%) hunters in the harvest group reported harvesting mallards compared to 888 (62%) in the no-harvest group (Table 2).

A total of 250 successful hunters (13% of total) were contacted through the telephone survey: 130 in the harvest card group and 120 in the no-card group. Of these hunters, 124 (95%) from the harvest card group and 112 (93%) from the no-card group responded. A significant difference ($p < 0.001$) in record keeping was found to exist between the two groups. For the preseason harvest card group, the card was used by 67% of hunters to estimate their harvest, whereas 18% kept their own records and 15% relied on memory. Of the hunters that did not receive a preseason harvest card, 53% kept their own records and 47% relied on memory to estimate harvest (Table 3).

An examination of the distribution of mallard harvest for hunters in the no-harvest record group shows distinct response peaks at digits ending in 0 or 5, and lesser peaks at 8 and 12 (Figure 1). Although response peaks were observed for the harvest record group, the magnitude of the peaks were lower than those for the no-harvest record group (Figure 2).

Individual digit preference occurred in reported mallard harvest for 497 (26%) waterfowl hunters in the combined groups. IDP was observed in 226 (22%) of responses from hunters in the harvest record group compared to 271 (31%) hunters.

TABLE 2  Mallard Harvest for Illinois Waterfowl Hunters with and Without Preseason Harvest Record

<table>
<thead>
<tr>
<th>Test group</th>
<th>n</th>
<th>Hunters harvesting 1 or more mallards</th>
<th>Total reported mallard harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preseason harvest record</td>
<td>1,717</td>
<td>1,036 (60%)</td>
<td>15,239</td>
</tr>
<tr>
<td>No preseason harvest record</td>
<td>1,430</td>
<td>888 (62%)</td>
<td>14,258</td>
</tr>
<tr>
<td>Total</td>
<td>3,147</td>
<td>1,924 (61%)</td>
<td>29,497</td>
</tr>
</tbody>
</table>
Digit Preference in Waterfowl Harvests

ers in the no-harvest record group (Table 4). The chi-square test for the two groups showed the difference in IDP was significant at \( p < 0.001 \).

Aggregate digit preference (ADP) was reduced by more than 50% through the use of harvest records. Analysis of ADP indicated that reported mallard harvest for 9% of hunters who received the preseason harvest card were rounded, whereas 19% of responses from hunters without the harvest card were rounded (Table 5). The \( t \)-test statistic indicated the difference in ADP between the two groups was significant at \( p < 0.015 \). ADP was less pronounced in the harvest

### TABLE 3  Harvest Recording Methods of Illinois Waterfowl Hunters

<table>
<thead>
<tr>
<th>Method</th>
<th>Hunters with harvest card ( (n = 124) ) (%)</th>
<th>Hunters without harvest card ( (n = 124) ) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily log</td>
<td>18</td>
<td>53</td>
</tr>
<tr>
<td>Harvest card</td>
<td>67</td>
<td>47</td>
</tr>
<tr>
<td>Memory</td>
<td>15</td>
<td>47</td>
</tr>
</tbody>
</table>

\( \chi^2 = 18.39, p < 0.001 \).

![Figure 1](Mallard harvest for hunters without record.)
record group, and the associated curve was smoother at higher reported harvest than for hunters who did not receive a preseason harvest card (Figure 3).

Discussion

Results of this study suggest waterfowl hunters exhibit digit preference when reporting season harvest from memory, and that this error can influence harvest estimates. Findings of this study further suggest that the use of the harvest record was significant in reducing both individual and aggregate digit preference for postseason, self-reported harvest of mallard ducks. These results support previous studies that indicate use of journals, diaries, or records by recreationists re-

TABLE 4 Individual Digit Preference (IDP) for Waterfowl Hunters with and Without Preseason Harvest Record

<table>
<thead>
<tr>
<th>IDP in reported mallard harvest</th>
<th>Mailed preseason harvest card</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No: 617 (69%) Yes: 810 (78%)</td>
</tr>
<tr>
<td>Yes</td>
<td>No: 271 (31%) Yes: 226 (22%)</td>
</tr>
</tbody>
</table>

($\chi^2 = 18.90, p < 0.001$).
duce recall error and the tendency for digit preference when reporting participation over time.

The results of this study provide evidence that digit preference and recall bias is operational not only in reported participation, but also in those activities where harvest data are reported. This reporting error may be an important factor in such activities as waterfowl hunting where total annual harvest is used to model populations and make management decisions.

The findings presented here offer an empirical comparison for IDP versus ADP. Hunters who received the preseason harvest card showed only a slight difference in IDP (22%) over what would be expected under uniform distribution, whereas IDP occurred in responses of 31% of those hunters who did not receive the harvest card. ADP was reduced by more than half among hunters who re-

**TABLE 5** Individual and Aggregate Digit Preference for Waterfowl Hunters with and Without Preseason Harvest Record

<table>
<thead>
<tr>
<th></th>
<th>No harvest record</th>
<th>Harvest record</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual digit preference</td>
<td>31%</td>
<td>22%</td>
<td>$\chi^2 = 18.90$</td>
</tr>
<tr>
<td>Aggregate digit preference</td>
<td>19%</td>
<td>9%</td>
<td>$t = 2.69$</td>
</tr>
</tbody>
</table>

**FIGURE 3** DP residuals for mallard harvest.
corded their harvests. These findings support the comparison of individual digit preference versus aggregate digit preference proposed by Beaman et al. (1997), as the harvest record group did not exhibit IDP to a significant degree above expected probability. The results of this study also support previous research that suggests accuracy (and therefore validity) of reported harvest increases with the use of harvest records.

Caution must be exercised in situations where daily harvest bag limits are represented by digits ending in 0 or 5. This point was made by Vaske et al. (1996) in respect to 5-day fishing licenses. These special cases, especially where hunter success may be relatively high, may provide natural response peaks for frequencies of reported harvests in digits ending in 0 or 5. Two such examples in Illinois are mourning doves (*Zenaïdura macroura*) with a daily bag limit of 15, and gray and fox squirrels (*Sciurus carolinensis* and *S. niger*) with an aggregate daily bag limit of 5. These species are numerous, harvested at high rates, and pursued by a high proportion of hunters (Miller, Campbell, & Yeagle, 2000). Use of harvest records for these species may help to minimize digit preference in harvest reports.

Digit preference, as with all forms of recall error, can have serious consequences for calculating hunter participation and wildlife harvest. Permutations of these errors can be magnified by several times when used to estimate days afield and harvests on statewide, flyway, or national levels. Further research is needed to determine the extent to which hunters may round up in reporting total harvest for a season and possible motivations for doing so. Factors accounting for such errors must be incorporated into calculations used to determine wildlife harvests.

References


