Sievänen, T., Erkkonen, J., Jokimäki, J., Saarinen, J., Tuulentie, S. & Virtanen, E. (eds.). 2004. Policies, Methods and Tools for Visitor Management. Proceedings of the Second International Conference on Monitoring and Management of Visitor Flows in Recreational and Protected Areas, June 16–20, 2004, Rovaniemi, Finland. Working Papers of the Finnish Forest Research Institute.

Affects of Road Sign Wording on Visitor Survey – Non-Response Bias

Susan M. Kocis[1], Stanley J. Zarnoch[2] & Donald B.K. English[3]

[1] U.S.D.A. Forest Service, Bridgeville, CA, USA
skocis@fs.fed.us
[2] U.S.D.A. Forest Service, Asheville, NC, USA
szarnoch@fs.fed.us
[3] U.S.D.A. Forest Service, Athens, GA, USA
denglish@fs.fed.us

Abstract: On-site visitor interviewer data collection is a key component of the USDA Forest Service National Visitor Use Monitoring (NVUM) program. In many areas, especially higher speed roads and roads with non-recreation traffic, many vehicles may not stop for an interview. Wording on the sign may condition non-recreation visitors to self-select as to whether or not they decide to stop for an interview. Since the primary purpose of the interview is to calibrate a mechanical traffic counter, such behavior can lead to bias in the resulting visitation estimate. Non-response bias of national forest traffic was examined by using four different wordings for road signs during NVUM interview days. The experiment was performed using a randomized block design with each treatment (sign) being applied to five different road locations (blocks). Statistical analysis was performed to determine if any particular sign wording significantly affected (1) the rate of visitor response and (2) the mix of visitors who stopped for interviews. Data analysis show that the total number of all interviews obtained, the proportion of interviews obtained to overall traffic, and the proportion of non-recreation interviews obtained were different using different sign wording. The total number of recreation interviews obtained and the proportion of recreation interviews obtained were not different statistically.

Introduction

The USDA Forest Service National Visitor Use Monitoring (NVUM) program collects data about visitors on National Forest System lands (English et al. 2001). It utilizes a stratified multistage sampling design that is based on rotating panels spread over a five year sampling cycle. All national forests in the U.S. are sampled once every five years, with approximately one-fifth of the forests in each of 9 regions sampled each year. This statistical methodology follows conventional sample survey techniques with a few modifications to incorporate specific situations inherent in sampling national forest for recreation use. As in all sample surveys, it is important to accurately determine the measurement variable on each sampling unit selected for the survey. In most natural resource monitoring and sampling situations, the primary measurement variable is directly observable and easily replicated. For instance, in forest inventory a standard diameter tape is used to measure tree diameter or a relaskop is used to measure tree height.

However, unlike other natural resource monitoring efforts the target measure for the NVUM process cannot be obtained directly. In the NVUM survey, the desired measurement variable is the number of people completing a recreation visit at a given recreation site on a given calendar day (referred to as a site visit or SV). Optimally, the measurement process would entail a 24-hour on-site interview protocol in which all people exiting the site were required to participate. This protocol is not possible for several reasons including the length of permitted work day, road department regulations, and government prohibitions against mandatory traffic stops. Consequently, the NVUM sample uses a daily site estimator for SV that gets at the measurement variable indirectly. Basically, a 24-hour mechanical vehicle count is taken along with 6 hours of on-site observation and interviewing. During the 6 hours of interviewing the interviewer places a series of signs along the roadway which encourage visitors to pull off the roadway at a designated interview point. Mandatory stops of randomly selected vehicles are not allowed and the road sign used originally said "Voluntary Recreation Survey Ahead, Please Stop". The NVUM process relies on the sign wording to minimize any self selection in the number and type of people who stop. The NVUM team suspected that non-recreationists may be less apt to stop for voluntary interviews, thus biasing upward the 6-hour exiting vehicle SV estimator towards more recreationists. Thus, three new signs that did not include "voluntary" or "recreation" in their wording were compared to the original sign.

The visitor use estimation process obtains:

- a ratio of exiting 6-hour observed vehicles to the 6-hour mechanical vehicle count which is used to calibrate the 24-hour mechanical vehicle count, yielding an estimate of total exiting vehicles for the 24-hour period (VEHC),
- an estimate of the proportion of exiting vehicles that are last exiting recreationists (PBAR), and
- average number of people per vehicle (PEOPVEH).

These three quantities are used to estimate SV, the 24-hour recreation use at the site with the estimator defined as

$$\widehat{SV} = PBAR * VEHC * PEOPVEH$$

The accuracy of the $\widehat{SV}$ estimator depends on how well each of the three components (PBAR, VEHC, and PEOPVEH) are estimated. The effects of various sign types should be most influential on the estimation of PBAR because it is totally dependent on the 6-hour interview and its computation is directly affected by the number of recreationists and non-recreationists that stop to be interviewed. For instance, if a new sign has a greater potential to "capture" a non-recreationist as compared to the original sign, the PBAR based on this new sign will be smaller than the original. Subsequently, this will reduce the site visit estimate due to its component in the $\widehat{SV}$ estimator. Obviously, if the new sign tends to be less conducive to non-recreationists, then the opposite effect is possible. Similar interpretations are also available for the behavior of recreationists to the sign. Thus, the effect of sign type on the accuracy of PBAR will be extremely important.

The VEHC component of the $\widehat{SV}$ estimator is virtually independent of the effect of sign types. It is obtained from data collected by the interviewer counting cars that are passing (whether or not they stop) by the interview station during the 6-hour interview period. It also uses the 6-hour and 24-hour vehicle counts, which are independent of the sign types. Thus, the accuracy of VEHC will not be addressed in this sign study.

Another result of non-respondent bias may be a bias of the demographic or occupancy level characteristics (PEOPVEH) within each exiting vehicle. It is conceivable that PEOPVEH may be affected by sign type. For instance, it is possible that parents driving a vehicle with numerous noisy children are eager to return home and would not stop for a "voluntary" interview sign whereas a middle-aged couple traveling leisurely would be more likely to stop. This may result in a negative biasing of the PEOPVEH variable. Although other similar scenarios could be possible, it is believed that this bias will be quite low, especially because past experience has indicated that PEOPVEH is quite stable between 2 and 3 per vehicle. Thus, the accuracy of PEOPVEH will also not be addressed in this sign study.

Methodology

Statistical Methods

This study evaluated the effect of the four sign types on non-respondent bias and variance using a randomized block design to test for differences in visitor response to wording on various road signs. The randomized block design is "an experimental design for comparing t treatments (in this case 4 different road signs) in b blocks (in this case 5 different roads). Treatments are randomly assigned to experimental units (site days) within a block with each treatment appearing once in each block" (Ott 1984, p. 551). Note that the most common randomized block has each treatment once in each block, but the generalized randomized block could have multiple occurrences as we had. In addition, a covariate called "cars" was used in the analysis to account for the differences in the total amount of car traffic on each road. This variable is the 6-hour exiting traffic count and was different for each road. By adjusting for this difference in traffic volume, the variability in the experimental design was reduced which increased the power for statistical tests and the comparisons between the sign means were adjusted to a common level of traffic volume. This design is referred to as a randomized block analysis of covariance.

Sign Types

NVUM tested four road signs with different wording at five locations. The signs consisted of the original sign plus three new signs with different wording. The wording chosen for the signs (treatments) was as follows:

- Sign 1: Voluntary Recreation Survey Ahead-Please Stop (original sign)
- Sign 2: Forest User Survey Stop Ahead
- Sign 3: Traffic Survey Stop Ahead
- Sign 4: Traffic Questionnaire Stop Ahead

The roads (blocks) were:

- Block 1: Grand Mesa Uncompahgre and Gunnison National Forest - Kebler Rd
- Block 2: Eldorado National Forest Ice House Road
- Block 3: Eldorado National Forest Mormon Emigrant Trail road
- Block 4: Eldorado National Forest County Road 63
- Block 5: Sequoia National Forest Hwy 180

Each of the roads had previously been surveyed at least twice using Sign 1. Interviewers then replaced sign 1 with signs 2, 3, and 4 at least one day each on each of the roads. All other interview procedures were followed as usual.

Variables

To assess the accuracy of the $\widehat{SV}$ estimator with respect to the sign types, several variables were defined to analyze the potential bias and variance of PBAR. Estimates of PBAR were compared between the four signs. If these estimates are similar, then it could be concluded that sign types do not alter any potential bias. If significant differences are detected, then it could be concluded that the signs do affect the bias and further consideration would have to be made to determine which has the most appealing bias. Three variables were used in the analysis to assess the bias and are defined as

- REC = number of last exiting recreationists that agreed to be interviewed,
- NREC= number of non-last-exiting recreationists that agreed to be interviewed and
- PREC=REC/(REC+NREC)= proportion of recreationists to all traffic

The variable PREC is analogous to PBAR in the $\widehat{SV}$ estimator and its value directly affects $\widehat{SV}$. The other two variables, REC and NREC, were analyzed to give information on what components of PREC are affected by the signs. For instance, if PREC changes among the signs, it is useful to further analyze REC and NREC to determine what component of the interviewed sampled is mostly affected.

In addition, the variance of the $\widehat{SV}$ estimator was investigated by comparing the number of interviews obtained by each of the four sign types. Generally, the variance can be decreased by simply increasing the total number of interviews obtained. Thus, signs that attract more interviews would possess a smaller, more desirable variance. The two variables used for this purpose are defined as:

- INTSDONE = the total number of interviews performed and
- PINTSDONE = the proportion of vehicles passing the interview location during the 6-hour survey that were interviewed.

INTSDONE is interpreted as the number of interviews that a sign has 'captured' and comparisons among the signs will determine which ones are most efficient sampling tools. However, since the traffic volume was not consistent for all survey days, it is conceivable that a specific sign type may have been exposed to more cars and, consequently, would be able to "capture" more for interviews. To adjust for this, the variable PINTSDONE was also used, which could be interpreted more as a rate of "capture" and this should be independent of traffic volume on any given survey day.

Results

The variables tested using the randomized block design analysis of covariance were based upon the number of interviews obtained REC, NREC, PREC, INTSDONE, and PINTSDONE (Table 1). A p-value of .05 or less indicates there was a difference between treatments. In most blocks sign 1 was used 3 or more times, while signs 2, 3, and 4 were used only 1 or 2 times (see Figure 1).

The total number of interviews obtained (INTSDONE) was significant (p=.025) and varied depending upon the sign wording used. The Tukey-Kramer test shows that sign 3 obtains more total interviews (38.3) than sign 1 (21.3). The results show that PINTSDONE (p=.037) and NREC (p=.027) also have significant differences for signs. However, for both variables the Tukey-Kramer test showed no significant differences between the means. However, it is highly likely that significant differences would have been found if the numbers of blocks were increased slightly. Thus, sign 3 and perhaps the other new signs tend to obtain more interviewed vehicles which should result in a decrease in the variance of the SV estimator.

The number of recreation interviews obtained (REC) and the proportion of recreation traffic that stopped for the different signs (PREC) does not show any statistically significant difference (0.757 and 0.121 respectively). However, it is interesting to note that although PREC did not meet the 0.05 significant levels, there is an indication that all three new signs tend to decrease PREC. The average for the new signs was approximately 0.50 while the original sign was 0.68. This difference was due to a larger NREC for the new signs while REC was about the same for all four signs. Since PREC is closely analogous to PBAR in the SV estimator, the effect of the new signs could decrease the SV estimator substantially. One may possibly conclude that NREC visitors did not stop at the original sign as eagerly as REC people, resulting in a non-respondent bias. The new

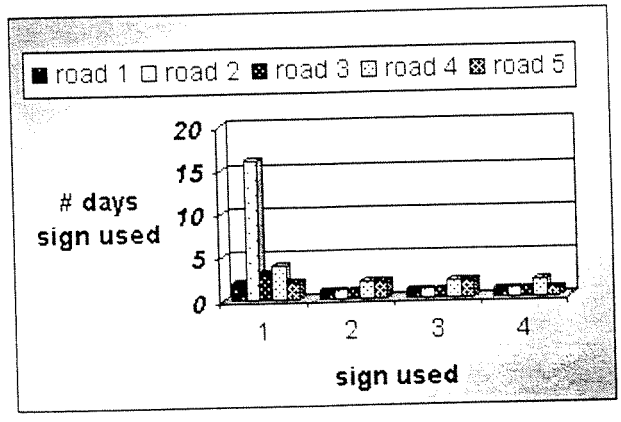

Figure 1. Number of days sign used on five roads using each sign treatment.

Table 1. Results of randomized block design analysis of covariance with "cars" as a covariate.

Variable	P-value	Least Squares Means			
		1	2	3	4
REC	.757	14.20[a]	15.40[a]	17.90[a]	15.60[a]
NREC	.027	6.10[a]	8.80[a]	15.60[a]	15.40[a]
PREC	.121	0.68[a]	0.49[a]	0.53[a]	0.49[a]
INTSDONE	.025	21.30[a]	28.70[ab]	38.30[b]	35.60[ab]
PINTSDONE	.037	0.12[a]	0.18[a]	0.19[a]	0.21[a]
Cars (average exit car count)		162.9	309.4	211.1	286.3

Means for signs in a row followed by the same letter are not significantly different based on the Tukey-Kramer test at the 0.05 level.

signs then appear to be sampling the visitors more randomly. Since PREC is closely analogous to PBAR, it is then conceivable that there is a 36% (100(0.68-0.50))/0.50=36) difference in the bias of the SV estimates based on sign 1 as compared to the new signs.

Recommendations

Accuracy of the measurement instrument and its resulting SV visitor use estimate depended upon both the potential for bias of respondents and the variability. Based upon the analysis of covariance it appears that the proportion of last existing recreationists, PBAR is affected by sign wording, which affects the bias of the SV estimator. More total interviews were obtained with signs 2, 3 and 4, with sign 3 having significantly more interviews. This sign reads "Traffic Survey Stop Ahead".

Management must then decide whether or not to use signs 2, 3, or 4. Ancillary information reported by the interviews, as well as the means in Table 1 showed that more people pulled over for signs that included the wording "Traffic" (signs 3 and 4) versus "Recreation" (sign 1) or "Forest User" (sign 2). However, in 3 of the 5 blocks tested, at least one non-recreationist was irritated when they were informed the survey was voluntary.

The NVUM team recommends using sign 3 to increase the total number of interviews obtained (INTSDONE) and to capture a more realistic picture of the proportion of recreation (PREC) traffic. Interviewers must be taught the proper approach with visitors. Since all the information collected from anyone who stops is used to obtain the SV estimate, all responses, whether REC or NREC are needed. The interviewer must be trained to:

- Thank the visitor for stopping and explain the purpose of the survey and
- Ensure the visitor knows their answers are used and valued.

References

English, D.B., Kocis, S.M., Zarnoch, S.J. & Arnold J.R. May 9, 2001. [Internet site]. Forest Service National Visitor Use Monitoring Process – Research Methods Documentation. Available from: http://www.fs.fed.us/recreation/programs/nvum [Cited 23 Jan 2004].

Lyman, O. 1984. An Introduction to Statistical Methods and Data Analysis (2nd Ed.). PWS Publishers, Duxbury Press, Boston. 551 p.