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Effects of Recall Bias and Nonresponse Bias on Self-Report Estimates of Angling Participation

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Abstract.—We addressed the problems of recall and nonresponse biases in self-report angling participation surveys. While each source of bias has been recognized as problematic, previous research has not addressed the interaction effects of these biases. Recall bias was assessed by comparing immediate, 3-month, and 6-month recall periods. A diary format was used for the immediate recall period and mail surveys for the 3-month and 6-month recall periods. Nonresponse bias was assessed by conducting telephone interviews with subjects who did not respond to the mail or diary surveys. The dependent variable was total number of days fished over two separate 3-month periods. Analysis showed significant first-order interactions ($P \leq 0.05$), suggesting that recall bias and nonresponse bias are not independent factors. Respondents are more likely to report higher levels of participation and nonrespondents lower levels of participation as the length of recall period increases. Findings indicate that studies which use long recall periods, or do not control nonresponse bias, overestimate use. Future studies can control recall and nonresponse biases by combining frequent sampling with telephone interviews that request short recall periods.

Effective management, planning, and development of recreational fisheries resources are increasingly dependent upon accurate and reliable data sources. An important aspect of this data collection process involves the retrieval, analysis, and evaluation of information concerning the behavior, preferences, catch, and effort of sport anglers. This information can be useful in a variety of ways, including the identification of use trends, projection of angler demand, evaluation of the impacts of management decisions, allocation of funding, and examination of user conflict.

As fisheries planners and managers have become more involved in the collection and use of angler information, they have become increasingly aware of measurement problems that can affect the validity and reliability of study results. One area of concern examined in our study is convergent validity. Convergent validity addresses the extent to which different methods give the same estimates of angling participation. When estimates of angling participation vary widely among estimation methods, it calls into question the validity of the estimates and limits their utility to managers.

The accuracy of estimates can be improved by examining the magnitude of biases that occur in existing survey methods and refining methodologies so they explicitly control for method effects. This study examines the effects of method bias in the Illinois Sport Fishing Survey (ISFS). The ISFS is the primary mechanism used to assess angler information in Illinois (Illinois Department of Conservation 1988).

The ISFS uses a mail survey for collecting statewide angler information, as do many other agencies (e.g., USFWS 1982; Harris and Bergersen 1985), because mail surveys are a cost-effective means of obtaining large amounts of data. Many sources of bias, however, can affect mail surveys (e.g., Nunnally 1978), and, specifically, nonre-

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sponse bias and recall bias have been identified as significant threats to the generalizability of fish and wildlife survey results (Filion 1980).

Nonresponse bias occurs when respondents inaccurately represent the original total sample, and hence the population under study (Assael and Keon 1982). Problems of nonresponse bias have been identified in a number of studies. For example, Harris and Bergersen (1985) conducted a statewide survey of Colorado anglers that included a telephone survey of nonrespondents to a mail survey. Findings revealed that average annual participation of respondents was 24 d compared to only 2 d for nonrespondents. The failure to account for nonresponse bias would have overestimated Colorado fishing participation by 132%. Lowry (1978) also identified nonresponse bias problems in a statewide survey of Oregon anglers and reported that 6% of the respondents had not fished, compared to 20% of the nonrespondents. Absher and Collins (1987) surveyed anglers using the southern Lake Michigan sport fishery and found that mail survey respondents reported taking 17.2 trips/year, while nonrespondents took only 12.8.

Recall bias reflects a subject's inaccurate recollection of particular events. It occurs when respondents either fail to recall certain events or inaccurately match their activity to the recall period specified (Sudman and Bradburn 1974). In studies of recreation participation, recall bias has typically produced overestimates of participation (Chase and Godbey 1983; Chase and Harada 1984; D. R. Chase and G. Godbey, Pennsylvania State University, unpublished). In particular, recall bias has been identified as a problem inherent in sportfishing surveys (Hiett and Worrall 1977; USNMFS 1980; Harris and Bergersen 1985). In most statewide angling surveys, subjects are asked to recall participation during a 6- or 12-month period. Evidence suggests that recall periods of that length of time produce inflated estimates of angling participation. For example, a study of marine recreational fishing by Hiett and Worrall (1977) found that the ability of anglers to accurately recall the number of fishing trips decreased as length of recall period increased. Brown (1977) recommended in a review of the literature on marine recreational fisheries surveys that the recall period for reporting of recreational grips should not exceed 2 months if problems of recall bias are to be minimized.

These studies of nonresponse and recall biases raise questions about the accuracy of self-report angling participation surveys. Furthermore, there appears to be a lack of research that has explicitly addressed the combined effects of nonresponse bias and recall bias in the same study. The traditional assumption has been that the two biases are independent of one another. Our study proposes, however, that the two forms of bias may be related. Research has shown that subjects tend to round upward when recalling recreation participation. This may represent a mixture of preference and factual reporting (i.e., individuals report the number of days they would like to have spent fishing) or subjects extending the time frame in their minds. In either case respondents probably would be more susceptible to recall bias because they have been shown to participate more than nonrespondents, and they have more interest in the sport.

The purpose of this study was to examine the effects of recall and nonresponse biases in self-report surveys and, specifically, to investigate the interaction of these phenomena in producing erroneous estimates of angling participation. It was hypothesized that, as recall period increases, respondents will report a higher number of days fished than nonrespondents.

Methods

Data for this study were collected during April–September 1989, from a sample of resident licensed anglers in Illinois. Recall bias was assessed by comparing 6-month, 3-month, and immediate recall periods. The 6-month and 3-month recall periods utilized a mail-back questionnaire. Data for the immediate recall period were collected using a diary method.

Subjects who were selected for the 6-month mail survey were sent a questionnaire, along with a cover letter and stamped return envelope, in the last week of September. Subjects were asked to recall the number of days they fished over the preceding 6 months. Two 3-month mail surveys were administered. The first 3-month mail survey was sent out during the last week of June, and subjects were asked to recall the number of days fished between April 1 and June 30 (Apr–Jun). The second was mailed in the last week of September, and subjects were asked to recall the number of days fished between July 1 and September 30 (Jul–Sep). Subjects who did not return the 6-month or 3-month mail questionnaires within 2 weeks of the requested date were sent a follow-up postcard.

Two diaries were sent out. The first collected information about angling participation in Apr–Jun; the second collected data for Jul–Sep. Subjects were sent the diary and instructions for its completion 2 weeks prior to the beginning of each

3-month period. Subjects were requested to record details about their angling trip (e.g., number of days fished, number of fish caught) immediately upon returning from their trip. The cover letter accompanying the diary informed subjects of the study's purpose, making them aware of the potential problems of recall. Subjects who did not return their diary within 10 d of the end of the recall period were sent a postcard reminder.

Nonresponse bias was assessed by conducting telephone interviews with subjects who had not returned their mail survey or diary within 3 weeks of the end of the respective recall period. Phone numbers of nonrespondents were obtained from listings in published phone directories. Up to five attempts were made to contact subjects, after which time the attempt was abandoned. Nonrespondents to the 6-month mail survey were asked to recall number of days fished over the preceding 6-month period. Nonresponse bias for the 3-month and immediate recall periods was estimated by asking nonrespondents to recall participation over the preceding 3-month period.

Sampling.—Subjects for the study were sampled from angling license sales in Illinois using vendor-return insert cards. Vendors inserted these cards at regular intervals in the license booklets. When the license was sold, the vendor recorded the name and address of the recipient and returned the cards. For this study, vendors were instructed to return cards to the Illinois Department of Conservation as soon as they were completed. License sale cards were divided into four regions, corresponding to where the sales occurred in Illinois. Anglers who purchased nonresident angling licenses in Illinois were excluded from analysis.

Samples for each of the three recall periods were drawn from the total number of returned insert cards. To be consistent with previous ISFSs, the 6-month recall period required a sample size of at least 2,000 anglers. This represented over two-thirds of the total number of returned insert cards. The remaining one-third of the returned insert cards were used as the sample for the 3-month and immediate recall periods. To avoid underrepresentation within the four regions of Illinois, a stratified sampling design was employed to obtain subjects for the immediate and 3-month recall periods. The strata were weighted to ensure that they were proportionally representative of the population of Illinois anglers. Given the relatively large number of returned insert cards, subjects for the 6-month recall period were obtained via a simple random sampling design.

Because subjects for the 3-month and 6-month recall periods could enter the sampling frame at any time during or prior to the April–September survey period, sampling was conducted continuously from the beginning of the license year (January 1, 1989) until mid-September 1989. Sampling for the immediate recall period began in January and was completed by the end of June 1989. In addition to new subjects, subjects who were sampled for the first 3-month and immediate recall periods were also sampled in the second 3-month and immediate recall periods.

Analysis.—Two-way analysis of variance (ANOVA) was used to test the effects of recall and nonresponse biases. The dependent variable was the total number of days a subject reported having fished during each 3-month period. The independent variables were length of recall period and whether the subject was a respondent or nonrespondent. A significance level of $P \leq 0.05$ was adopted.

Due to the anonymity of respondents, subjects in the Apr–Jun period could not be matched with subjects in the Jul–Sep period. For this reason data for the two 3-month periods could not be combined into a single 6-month period. Instead, two separate ANOVAs for the Apr–Jun, and Jul–Sep recall periods were conducted. Data from the 6-month mail and nonresponse phone surveys were split into Apr–Jun and Jul–Sep periods and compared to the 3-month and immediate recall periods.

Results

A response rate of 42.4% (N = 2, 142 anglers sampled) was obtained for the 6-month mail questionnaire. The two 3-month mail surveys achieved response rates pf 36.5% (N = 190, Apr–Jun) and 36.9% (N = 221, Jul–Sep). The two diaries received response rates of 15.0% (N = 78, Apr–Jun) and 17.5% (N = 91, Jul–Sep). There were 104 completed nonrespondent telephone calls for the 6-month survey; 136 and 174 for each of the two 3-month surveys; and 236 and 396 for each of the two diaries.

To satisfy the equal sample size assumption required for the ANOVA design, a 10% random subsample for the 6-month mail survey (N = 216, Apr–Jun; N = 223, Jul–Sep) was obtained using the sample procedure in SPSS (Norusis 1991). This procedure ensured that sample sizes were relatively equal across the independent effects. Further analysis showed that several different 10% random subsamples produced similar results. Also, results

TABLE 1.—Two-way analysis of variance of number of days fished per angler for recall bias by nonresponse bias for April–June. Etas (η) for nonresponse and recall effects were 0.16 and 0.11, respectively.

Source of variation	Sum of squares	df	Mean square	F	P
Main effects					
Recall bias	1,142.5	2	571.3	3.5	0.03
Nonresponse bias	3,728.7	1	3,728.7	22.9	<0.01
Interaction					
Recall by nonresponse	3,813.7	2	1,906.8	11.7	<0.01
Residual	155,385.2	956	162.5		
Total	164,794.3	961	171.5		

did not differ substantially from those based on the entire sample.

Results from the two-way ANOVA of number of days fished per respondent are shown in Tables 1 and 2. Significant interactions for the two 3-month periods imply that the effects of nonresponse were dependent upon the length of recall period.

Examination of the means (Table 3) suggests that in the 3-month and 6-month recall periods, respondents reported fishing almost twice as many days as nonrespondents. In the immediate recall period, however, respondents reported fishing fewer days (Apr–Jun), or about the same number of days (Jul–Sep), as nonrespondents. Mean values for both respondents and nonrespondents were typically greatest at the 3-month recall period.

Discussion

This study indicated that nonresponse bias and recall bias are not independent factors when evaluating self-reports of angling participation. Before reviewing the findings, and related implications, three limitations to our study must be acknowledged. First, nonresponse bias in the immediate recall period was assessed by asking nonrespondents to recall the number of days fished over a 3-month period. Ideally, nonrespondents to the diary would have been asked to recall participation closer to the time of actual participation. This was not possible using our design. It should be noted, however, that all subjects in the immediate recall period were instructed, in advance, to record angling participation immediately after it occurred. The extent to which this request may have influenced nonrespondent estimates in the immediate recall period is not known. It is also plausible that the inconsistent pattern across the two 3-month periods for the immediate recall period may be a function of survey requests. Nonrespondents in the immediate recall period may have been more aware of their participation during the second 3-month period because of the amount of correspondence they received in the first 3-month period, even though they did not complete or return their diary.

TABLE 2.—Two-way analysis of variance of number of days fished per angler for recall bias by nonresponse bias for July–September. Etas (η) for nonresponse and recall effects were 0.18 and 0.13, respectively.

Source of variation	Sum of squares	df	Mean square	F	P
Main effects					
Recall bias	803.6	2	401.8	2.6	0.08
Nonresponse bias	3,579.8	1	3,579.8	22.9	<0.01
Interaction					
Recall by nonresponse	1,265.7	2	632.8	4.1	0.02
Residual	188,352.0	1,203	156.6		
Total	196,705.6	1,208	162.8		

A second potential limitation concerns the low response rates obtained for the 6-month and 3-month mail surveys and, in particular, the diary survey. The low response rates may have contributed to the main effect exhibited for response bias in both the Apr–Jun and Jul–Sep recall periods. Higher response rates (e.g., 60%, 70%, or 80%) may have produced different results. It should be noted, however, that response rates as low as 15–40% are common when diary and mail-back methods are used without follow-up surveys of nonrespondents. Since surveys of this nature are sometimes used by managers, there is clearly a practical relevance in our findings. The need to examine method bias remains an important area for future research in the fisheries literature.

Third, although ANOVA is a fairly robust design (Hays 1988), violations of its basic assumptions should be acknowledged. Two violations were apparent in our study. First, there was heterogeneity of variance for the response effect. Second, the data were positively skewed; this is a common concern for any study attempting to measure participation estimates. Research suggests, however, that even severe violations of these two assumptions, given relatively large samples sizes, do not distort the distribution of the F-statistic seriously (Myers 1979; Hays 1988).

Recognizing these limitations, we tentatively conclude an interaction between nonresponse bias

TABLE 3.—Number of days fished per angler (mean ± SD) in April–June and July–September, by recall period and nonresponse biases.

	Immediate recall	3-Month recall	6-Month recall	Total
		April-June		
Respondent	6.8 ± 6.4	14.9 ± 15.2	12.4 ± 14.0	12.5 ± 13.5
Nonrespondent	9.4 ± 16.0	8.4 ± 11.4	5.1 ± 8.1	8.2 ± 12.3
Total	8.8 ± 12.5	12.2 ± 14.2	10.1 ± 12.4	
		July-September		
Respondent	6.7 ± 8.9	11.3 ± 14.4	11.8 ± 13.0	10.7 ± 13.1
Nonrespondent	6.0 ± 10.3	7.1 ± 14.7	5.2 ± 9.0	6.1 ± 11.5
Total	6.1 ± 10.1	9.4 ± 14.6	9.7 ± 12.9	

and recall bias. Interestingly, these biases appear to produce somewhat counterbalancing effects when estimates of angling participation are made. Respondents' reports of participation increase with longer recall periods, while nonrespondents' reports were more likely to decrease. Further, estimates of participation, adjusted for nonresponse bias, were lowest for the immediate recall compared to the 3-month and 6-month recall periods.

One implication of this study suggests problems of interpreting results of previous studies where recall and nonresponse biases were not controlled. To illustrate this point a recent study by Tarrant et al.[2] (1991) compared estimates of total angling participation for Illinois derived from the three recall periods (adjusted for nonresponse bias) to estimates derived from methods employed in previous Illinois sportfishing surveys (Illinois Department of Conservation 1982, 1985, 1988, 1991). Previous ISFSs have used a 6-month recall period method that was not adjusted for nonresponse bias. Findings show that the ISFS method produces much higher estimates of participation than the three recall periods adjusted for nonresponse bias. For example, the 1989 ISFS estimate (Illinois Department of Conservation 1991) of 32,158,555 angler-days was 40% higher than the estimate derived from the immediate recall period, 24% higher than the 3-month recall period, and 25% higher than the 6-month recall period. Similar comparisons were found for the three earlier studies.

A second implication of these findings is that future studies assessing angling participation need to employ methods that minimize, or control for, nonresponse and recall biases. The optimal (i.e., most cost-effective) approach to determining participation estimates would be a method that can control for both recall and nonresponse biases. We recommend that an appropriate method would be a single-wave telephone interview. Telephone interviews are generally more accurate, produce higher response rates, and do not differ appreciably in costs when compared to mail surveys (Hunt and Dalton 1983). Telephone interviews could survey anglers regarding their participation over a short interval (e.g., 2 weeks), with sampling occurring throughout the year. Given that most angling participation occurs during the spring through fall, sampling could be higher during these seasons than during and winter. Telephone interviews requiring short recall intervals and having the greatest sampling during appropriate periods would also assure some control over weekly and seasonal fluctuations. This approach has received widespread and successful use by Juster and Stafford (1985) and Brooks (1987), among others, to reduce the potential for recall bias when asking subjects to account for allocation of time spent on, and frequency of, leisure-related activities.

Finally, the interaction effects of recall and nonresponse biases on participation estimates need to be investigated in respect to self-reported catch and harvest, as well as to other types of recreation-related activities. Results of this study suggest that previous estimates of catch and harvest may need to be reevaluated depending upon the length of the period of participation subjects were asked to recall.

[2] The data reported here are part of a larger research project that produced statewide population estimates in Illinois, adjusted for recall and nonresponse biases (see Tarrant et al. 1991). Requests for copies of the project, as well as information regarding sampling procedures and estimating population parameters, may be directed to Michael Tarrant.

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