WEIGHTING ISSUES IN RECREATION RESEARCH AND IN IDENTIFYING SUPPORT FOR RESOURCE CONSERVATION MANAGEMENT ALTERNATIVES

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Abstract: Sampling for research in recreation settings in an ongoing challenge. Often certain groups of users are more likely to be sampled. It is important in measuring public support for resource conservation and in understanding use of natural resources for recreation to evaluate issues of bias in survey methodologies. Important methodological issues emerged from a statewide project assessing sport fish consumption patterns of state anglers. The objective of the project was to determine an average consumption rate for fish obtained through recreational fishing. Although two methods were used to reach anglers, a mail survey and an onsite survey, the latter method was subject to participation bias among anglers interviewed in the on-site locations. The most active anglers were more likely to be encountered and interviewed by the survey team. As higher participation levels in fishing are likely associated with more opportunities for catching fish, more active anglers are likely to have higher consumption rates. More active anglers' consumption data would contribute to an estimate of average consumption rate calculation that was too high among anglers interviewed in the on-site locations. Weighting data based on the inverse of fishing participation was necessary to address the participation bias, and sport fish consumption was calculated with weights assigned. Comparison of weighted data with unweighted data is provided. Average consumption rate for active consumers assessed using weighted on-site data was similar to the rate observed for active consumers in the mail survey. Weighting was necessary to calculate an estimate of average sport fish consumption among on-site anglers and to provide information to the funding agency for policy decisions.

Introduction

Sport fish consumption is an issue of importance in human dimensions research based on health and safety issues associated with consuming potentially contaminated fish. Substances that accumulate in fish, such as polychlorinated biphenyls (PCBs), pose a risk for people who eat fish. The risk increases with larger or specific species of fish (Hutchison and Kraft, 1994). Fish consumption patterns are particularly of concern when sport fish form a substantial portion of angler diets and household meals.

Many states have issued fish consumption advisories for specific water bodies. These advisories help anglers choose between site alternatives (Jakus, Downing, Bevelhimer, and Fly, 1997). To set the levels of consumption for advisories, state agency personnel assess patterns of fish consumption by anglers who consume sport fish; this definition does not include fish purchased at a store or restaurant. Certain angler groups are of particular concern if they consume sport fish at higher levels than the general public and are therefore at higher risk from consuming contaminants in fish.

Methodologies can be chosen to reach different segments of the angling population to collect consumption data. Approaches to statewide surveys have varied. Mail surveys targeting licensed anglers may reach a majority of the angling public. Yet subpopulations of anglers, such as anglers who do not purchase licenses, may not be represented in survey data. For example, a statewide survey in Wisconsin had indicated a general compliance with the consumption advisory, but potentially overlooked ethnic minorities (Hutchison and Kraft, 1994). Diaries have been used to assess awareness of advisories and fish consumption behaviors (Connelly, Knuth, and Brown, 1996). In the Great Lakes region, several states, such as Michigan (West, Fly, Marans, Larkin, and Rosenblatt, 1995) and New York (Connelly et al., 1996) as well as the province of Ontario have collected fish consumption data; however as of 1997, no comprehensive data had been collected of consumption of fish from Indiana state waters. For this reason, the Indiana state Departments of Environmental Management, Health, and Natural Resources initiated efforts through researchers at Purdue University to conduct a statewide fish consumption project.

When measuring fish consumption levels, it is important to address variation in the estimates based on use of different methods and variables (Cavan, Gibson, Cole, and Riedel, 1996). Biases inherent in a particular methodology need to be considered. In on-site interviews, participation bias will affect fish consumption calculations, because highly active anglers are more likely to be interviewed. Weighting is used to address this bias and correct the data for a more accurate estimate of the measure of interest, namely average consumption rate by sport anglers in a region.

Need for Weighting On-site Interview Data

The use of weighting must be considered carefully. This has been noted for making inferences from recreation research (Christensen, 1979). Often the reason for using weighting is to correct for selection bias (Whitehead, Groothuis, Hoban, and Clifford, 1994). Weighting has been identified previously as an issue in food consumption research (Tucker, Bianchi, Maras, and Bermudez, 1998) and in nutrition surveys (Osler and Schroll, 1992). It has been used to avoid bias in certain estimates resulting from those of higher social status, such as higher-income groups participating at a different rate (e.g. times per year) than others in the population (Harou, 1982). Among those interviewed onsite it may be necessary to correct for a 'travel time bias' in making particular estimates of use (Wna, 1989). Weighting may also be employed to correct for differing variability in observations. In one case of using weighted least squares estimation the issue is getting more reliable estimates not removing bias (Beaman, Knetsch and Cheung, 1977).

In recreation research, the selection of a respondent often depends on the level of participation in a recreational activity at a location. Onsite survey methods must be designed with due consideration of how respondents are selected and how this should impact on their contribution to getting unbiased estimates of a particular measure of interest. How respondents are selected can result in unweighted averages of expenditure and person days of site use both being biased. Getting unbiased estimates requires 2 different weighting schemes.

If different respondents exhibit a different level of participation based on some measure, e.g., visits, and respondents are selected for interview on final exit, one must consider what measures to estimate to meet various survey objectives. Some people visit a site only 1 or 2 times a year but may stay for 2 weeks one of those times. Others make repeated visits to a place (every nice weekend for 15 or 20 weekend and day-visits). This is an issue when measuring use at national parks, at forest areas or at specific fishing sites (Beaman and Redkop, 1990; Price, 1991; Roeder, 1973).

Methods

The 1997-1998 Indiana sport fishing consumption survey questionnaire and administration methodology was designed based on past fish consumption research. A literature review was conducted focusing on past work on fish consumption patterns among anglers. A variety of survey methodologies have been used in the past, such as mail questionnaires, diaries and personal interviews. Calculations of consumption rate, specific wording of questions for variables to be measured, and visual aids were particularly noted within these methodologies. Based on discussions with the state agency and respective committees, two methodologies were selected: a mail survey of licensed anglers, and an onsite survey of anglers fishing in lakes and/or rivers near urban regions. It was deemed important to develop an on-site survey to reach angler segments potentially overlooked in the mail survey, such as non-licensed anglers, retirees who are not required to buy a license and minority groups fishing for subsistence purposes. An attempt was made to reach minority and lower income anglers by focusing on urban areas where the proportion of the population in these groups was higher than in non-urban areas. Survey locations were fishing places easily accessible to East Chicago, Hammond, and Fort Wayne in the north, Indianapolis in the central region, and Jeffersonville and Evansville in the southern part of the state. It is the on-site project that is the focus of this discussion. Weighting was necessary to correct for participation bias from highly active anglers who were more likely to be sampled in the on-site locations.

Variables

Two variables needed to calculate consumption rates are typical portion size and how often a respondent ate fish for a meal based on a specified recall period, such as number of meals per week in the past month. Recall periods found in the literature range from weeks to years. A three-month recall period was chosen for the Indiana project, and within that time frame respondents chose meal frequencies, e.g., once a week. In addition, a third variable, fishing frequency, was also measured in the Indiana project to determine level of fishing participation. Questions used for measuring consumption rate and fishing activity were:

1) "In the last three months, how often did you go fishing in Indiana waters?" (A six-point scale ranged from less than once/month to 5-7 days/week.)
2) "In the last three months, how often did you eat Indiana sport fish?" (A six-point scale ranged from less than one meal/month to 5-7 meals/week.)
3) What portion size would you say that you normally consume in a typical meal (An eight point scale ranged from less than 4 oz. to 16 oz., and respondents were given four photographs of 6, 8, 10, and 12 oz. fish portions as visual aids).

Respondents who noted both a typical portion size and a meal frequency during the three month recall period were defined as active consumers. Respondents who indicated a typical portion size but selected "never" as the response for how often they ate fish in the last three months were defined as potential consumers. These potential consumers were assumed to eat fish at other times of the year.

Calculating Consumption Rate

Calculation of consumption rate was based on the method used by Meredith and Malvestuto (1996). The result is presented as grams per day (GPD). The calculation used to determine an angler's gpd was:

$$C_{daily} = \frac{(ps)\,(m)\,(28.35\ grams/oz)}{30}$$

Where: C_{daily} = daily consumption of sport fish (ounce)
ps = portion size (ounces)
m = number of meals per month

less than once a month m = 0.5

Once a month	m = 1
2-3 days a month	m = 2.5
Once a week	m = 4
2-4 days a week	m = 12
5-7 days a week	m = 24
Not at all	m = 0

Weighting Consumption Data

It was important to correct for the bias from highly active anglers when calculating the consumption rate for sport fish among Indiana anglers interviewed in the on-site survey. Those who fish frequently were more likely to be selected by personal interview of people actively fishing in an on-site survey than those who fish infrequently. Computing an unweighted average of consumption rates across all respondents would have resulted in an artificially high consumption rate value. For this reason, it was necessary to weight consumption rates to correct for this frequency bias. This is achieved by weighting each respondent by the inverse of some fishing activity rate. Table 1 shows the weights that were assigned to each case by using the inverse of the fishing frequency measure obtained for the recall period.

Table 1. Weights assigned to on-site respondent data.

Variable Response	Code for fishing frequency/month	Weight Assigned
< Once/month	0.5	1/0.5 = 2
Once/month	1	1
2-3 times/month	2.5	0.4
Once/week	4	0.25
2-4 times/week	12	0.0833
5-7 times/week	24	0.0417

Findings

Average consumption rates for respondents of the Indiana on-site and mail surveys are given in Table 2. By our definition, active consumers had recently eaten fish (in the last three months). Potential consumers had not eaten fish in the last three months, so their consumption rate value was zero; however they indicated a typical portion size suggesting that they do consume fish. Therefore their zero consumption rates were incorporated into the average. When weights were assigned to the on-site data, the on-site active consumers (22.9 gpd) showed an average consumption rate that is very similar to that observed in the mail survey (19.8). In contrast, presenting the data without assigning weights would have led to the conclusion that on-site anglers are consuming fish at a higher rate than respondents to the mail survey. Such an estimate would have been too high as a result of the bias introduced by interviewing too many active anglers at the on-site survey locations.

Table 2. Average consumption rates by respondent type.

	Active Consumers		Potential and Active Consumers	
Survey Method	Onsite	Mail	Onsite	Mail
GPD Weights Assigned	22.9	19.8	9.8	16.4
GPD Not Weighted	32.3	19.8	17.9	16.4

Weighting was necessary to eliminate bias and thus get reasonably accurate estimates of the grams per day calculation average across income levels of interest. Four income categories were compared to assess potential differences in average consumption rates by anglers in each group and determine if anglers with lower incomes are consuming higher levels of sport fish. Data in Table 3 show that those with incomes less than $25,000 are consuming on average the same amount of fish (18.9 gpd) as those in the second category (18.8 gpd), and are actually consuming less than anglers in the highest income category (48.9 gpd). Getting weighted estimates shows that the difference in consumption rate between the highest and lowest income groups is greater than would have been concluded using data presented without weights assigned.

Table 3. Consumption rate by income among active consumers.

Income Level	<$25,000	$25,000-34,999	$35,000-49,999	$50,000 or more
GPD Weights Assigned	18.9	18.8	15.2	48.9
GPD Not Weighted	30.4	26.9	29.3	41.3

Consumption rates were compared across racial groups using the categories of white and minority active consumers. When weights were assigned to the data, findings showed that minority anglers were consuming significantly higher levels of sport fish (Table 4). A significant difference would not have been recognized using unweighted data (Table 5).

Table 4. GPD for active consumers by race, weights assigned.

Race	N	Mean	Std. Dev.
White	177	20.0	33.0
Minority	143	27.2	45.7
Significance (p-value): 0.000			

Table 5. GPD for active consumers by race, weights not assigned.

Race	N	Mean	Std. Dev.
White	177	27.8	39.5
Minority	143	38.3	55.9
Significance (p-value): >0.05			

Discussion and Implications

This research provides an example of the potential impact of biases in research conducted in recreation settings. On-site interviews have a frequency of participation or length of stay bias that can be corrected by weighting techniques to provide unbiased or less biased estimates of the measure of interest. Considerations of bias should be made at the outset, before the research project begins. Having collected data one may find that they can only produce biased estimates with no idea of the magnitude. Preplanning will hopefully result in collection of appropriate data for bias correction or selection of a method for which bias correction is not necessary for estimates of concern. Whether or not to use weighting depends on the measure of interest. In the fish consumption project the objective of the agency was an average measure for on-site anglers statewide. Selection of the weighting method and other methodological issues depends on the sample, and what is to be estimated which, of course, depends on the purpose of the study. Continued discussion of weighting can help promote its use where necessary.

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