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A Comparison of Revealed, Stated, and Actual Behavior in Response to a Change in Fishing Quality

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Due to water quality problems at its fish culture stations, Pennsylvania stocked 28% fewer catchable trout in 2002 than it had in prior years. The impact of this stocking decrease on license and trout stamp sales was projected based both on an econometric analysis of historical license sales (revealed behavior) and on a telephone survey of trout anglers (stated behavior). The econometric analysis showed no relationship between stocking levels and angler participation. However, in the telephone survey, 11.5% of current trout anglers stated that the cut in stocking would lead them to stop fishing for trout, including 3.2% who would stop fishing altogether. The projections based on stated behavior did a better job predicting resident license sales than did the projection based on revealed behavior, but anglers overstated their tendency to stop buying trout stamps.

Keywords sport fishing, license sales, stated preference, revealed preference

Introduction

Economists define the value to an individual of a recreation opportunity, such as a trip to engage in fishing, hunting, or wildlife viewing, or a license to participate in fishing or hunting for a season, as the largest amount of money the individual would be willing to pay for the opportunity. It is of interest to know these values, and how they might change as the quality of the recreation opportunity changes, for two reasons. First, knowledge of the value to the recreationists is needed to conduct cost-benefit analyses of resource management and programming decisions that affect the quality of the recreation resource. Second, knowledge of values allows projections of changes in participation (and changes in revenues generated by user fees) in response to changes in resource quality (e.g., Adams, Bergland, Musser, Johnson, & Musser, 1989).

Methods to measure the value of recreation opportunities fall into two categories; revealed preference methods, including the travel cost method and analyses of historical recreation participation, and stated preference methods, including the contingent valuation and stated choice methods. In revealed preference approaches, the value to an individual of a recreation opportunity is inferred from observed behavior such as travel to visit a

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recreation site or purchase of a license to engage in the recreation activity. It is assumed that if the recreationist visits the site, or purchases the license, then the value of the associated recreation opportunity exceeds the cost to the recreationist. In stated preference approaches, potential recreationists are asked in surveys how they would behave in hypothetical recreation decision situations. Willingness to pay for recreation opportunities can then be inferred from this stated behavior.

Revealed preference methods have a presumed advantage over stated preference methods because they rely on actual behavior in response to real incentives, rather than hypothetical statements about behavior or preferences. Because respondents to hypothetical questions have less incentive to carefully consider the costs and benefits of alternative actions, stated preference data may exhibit more variability than revealed preference data, or may even suffer from systematic bias, termed hypothetical bias. At the same time, stated preference data has some advantages as well. The existing set of recreation opportunities may not be rich enough to allow estimation of some recreation values. In such cases, stated preference techniques have the advantage of being able to generate data on recreation opportunities that do not currently exist (Adamowicz, Louviere, & Williams, 1994).

Motivated by concern over the potential for hypothetical bias, a great deal of research has been conducted evaluating the validity of stated preference methods. Most of these studies have either been tests of convergent validity, where values estimated from stated preference data are compared to values estimated from revealed preference data, or tests of criterion validity where stated hypothetical behavior is compared to behavior in simulated markets.

The results of convergent validity studies have been mixed. Carson, Flores, Martin, and Wright (1996) reviewed 83 studies that compared estimated willingness to pay values generated from stated preference data to values generated from revealed preference data. On average, values estimated from revealed preference data tended to be slightly larger than values for the same good estimated from stated preference data, but in individual cases the two approaches gave value estimates that differ by as much as an order of magnitude.

Several studies of criterion validity of stated preference techniques have found that survey respondents may overstate the likelihood of paying for an environmental or recreational good, relative to behavior revealed in simulated markets. Two early studies compared hypothetical statements about values of special hunting permits to actual payments in simulated markets. Bishop and Heberlein (1979) found that the amount that hunters said they would have to be paid to give up a special goose hunt permit exceeded actual willingness to accept by 60%. In a later study (Bishop & Heberlein, 1986), they found that stated willingness to pay for a deer hunt permit exceeded actual willingness to pay by 33% to 79%. Harrison and Rutström (2005) reviewed 14 studies that compared stated preference estimates of willingness to pay to estimates derived from experimental or simulated markets. Of 39 stated preference willingness to pay estimates, 23 showed significant positive hypothetical bias, with a median bias of 100%.

Whereas the validity of stated preference techniques has been the subject of a great deal of research, there has been much less attention paid to the validity of revealed preference valuation techniques. Data on past behavior may lead to spurious conclusions about either value or future behavior. This could happen for several reasons. First, the analyst may not be able to accurately measure the costs faced by the recreationist, particularly the opportunity cost of time. Second, the analyst may apply an innappropriate analytical model when interpreting the observed behavior. Third, the set of circumstances within which

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recreation behavior has been observed may not be rich enough to reliably reveal how recreationists would behave under new circumstances.

A planned decrease in trout stocking by the Pennsylvania Fish and Boat Commission (PFBC) provided an opportunity to compare predictions of behavior generated by both stated preference and revealed preference techniques to actual behavior in response to a policy change, providing tests of convergent validity between the two types of data and criterion validity of each type of data. From 1985 to 2001, trout stocking in Pennsylvania held fairly steady at about 5 million fish per year. In 2002, to remediate water quality problems at its fish culture stations, the PFBC reduced the number of adult trout produced and stocked in the state by 1.4 million fish, or 28%.

Prior to the stocking decrease, in 2001, the PFBC funded a survey of resident trout anglers to predict the impact that the stocking decrease would have on angler participation. At the same time, a second prediction of angler participation was developed based on an econometric analysis of historical license sales. Thus, two different predictions of the impact on angler participation of a change in fishing quality can be compared; one based on revealed-preference data, the other based on stated-preference data. These can both, in turn, be compared to the actual change in angler participation that occurred in 2002, when the stocking reduction was implemented.

Previous Studies of Angler Satisfaction and Participation

If stocking levels have an effect on fishing participation, the effect is assumed to work through a series of linkages. The number of fish stocked in Pennsylvania waters influences catch rates (or fishing success), which in turn influence angler satisfaction. Prior to the fishing season, potential anglers evaluate their expectations about fishing success and fishing satisfaction, and decide whether the benefit they receive from fishing exceeds the cost of the license. This section reviews three sets of studies; (1) survey studies that investigate factors that influence fishing satisfaction, (2) survey studies that investigate factors that influence fishing participation, and (3) econometric studies of historical data that identify factors that influence license sales.

Several studies have used surveys to identify factors that influence fishing satisfaction. In a 1996 survey (Responsive Management, 1996b), Pennsylvania anglers expressed high levels of satisfaction with their fishing experiences. When asked about factors that took away from their satisfaction, 21% responded that “pollution or litter” detracted from their enjoyment, 18% responded “not enough game fish,” 18% said “interference from others,” and 16% reported “work obligations” kept them from enjoying fishing as much as they would have liked.

Holland and Ditton (1992) examined fishing trip satisfaction in Texas. They narrowed their inventory of all dimensions of fishing trip satisfaction to six: (1) sense of freedom, (2) excitement, (3) competency, (4) relaxation, (5) enjoying the natural setting, and (6) reflection on past experience. Enjoyment of nature and a sense of freedom were the two most important factors of satisfaction, followed by excitement and competency.

A random sample of 1,600 Pennsylvania trout anglers (Hummon & Greene, 1993) gave the following ranking of factors that are important to a satisfying fishing experience: (1) close to home, (2) nice environment, (3) special waters—clean water or good fishing holes, (4) uncrowded, (5) catch trout, and (6) stocked trout. In a 1997 survey (Heberling, 1997), Pennsylvania anglers listed factors important to their choice of a fishing site. Nearly 60% of the respondents mentioned peace and quiet as a prominent factor. The next-most-often

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listed factors were an uncongested environment (55%), type of fish (45%), number of fish caught (39%), and nice scenery (35%).

A common finding of these surveys is that number of fish caught does contribute to fishing satisfaction, at least for some anglers, but is for most anglers a less important determinant than other factors such as the physical setting of the fishing experience and social factors.

Other surveys have investigated factors, including fishing success, that influence angler participation. Fedler and Ditton (2001), in a survey of Texas anglers, found that although half of the anglers surveyed fish consistently, year after year, the rest "drop in" and "drop out" over time. Most significantly, 25% of anglers who purchased a license in any given year were likely to not purchase a license within the next one or two subsequent years, with time constraints as the most commonly cited reason for not participating.

In a 1996 survey, inactive anglers in Pennsylvania (anglers who had fished in 1995, but who did not buy a 1996 license) were asked their reasons for not buying a license (Responsive Management, 1996a). Respondents were not prompted, and could list multiple reasons. The most common reason given was a lack of free time, due to work, family, or other commitments. Eight percent of inactive anglers cited license cost as a reason for not buying a license. Only a few inactive anglers mentioned the quantity of fish (4%) or quality of fish (2%) as reasons for not buying a license.

In a survey conducted between 1993 and 1996 (Responsive Management., 1996b) inactive anglers were read a list of reasons to not buy a license, and asked how strongly each reason influenced their own decision. Among inactive Pennsylvania anglers, the most commonly cited factor was a loss of interest (62%). Other common reasons given included lack of free time, no one to fish with, work and family obligations, and license cost. Ten percent of surveyed anglers stated that the quantity of game fish available influenced their decision whether to fish.

Taken together, these studies consistently found that a small number of anglers do state that quantity of fish available and fishing success influence their participation decisions, but that other factors are more important for most anglers.

Finally, several studies have used econometric techniques to identify factors that influence license sales. Two studies looked specifically for a link between stocking rates and aggregated license sales. Loomis (1999) found no statistical relationship between the two in an analysis of statewide license sales in California. Likewise, Loomis and Fix (1998) found no statistical relationship between statewide license sales and stocking levels in Colorado.

Although these studies did not find a relationship between stocking levels and license sales, license sales are sensitive to license price. Teisl, Boyle, and Record (1999), in a study of anglers in New England, found that a 1% increase in the resident fishing license price leads to a 0.05% decrease in resident license sales, whereas a 1% increase in nonresident fees leads to a 2.83% decrease in sales. Sutton, Stoll, and Ditton (2001) found that an 18% increase in license price to a unique fishing spot in Texas will lead to a 10% drop in sales, implying a 0.55% drop per 1% increase in license price.

To summarize, at least some anglers claim that stocking levels and success rates are factors that influence their fishing satisfaction and participation. Although other factors are more important for most anglers, the number of anglers who state that the quantity of fish available affects their participation is large enough to be important to resource managers. At the same time, empirical analyses of license sales data show no link between stocking levels and license sales. Either anglers overstate the influence that fish quantity has on their participation decisions, or historical license data are not rich enough to reveal the relationship.

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This study attempts to resolve the apparent contradiction, by comparing survey-based predictions of fishing participation after a change in stocking levels to predictions based on an econometric analysis of historical license sales.

Methods

Analysis of Historical Participation

To determine the relationship between stocking rates and license sales, the authors analyzed license sales data from Pennsylvania over the period 1970–2001. Data on license sales prior to 1970 is available, but the authors were reluctant to include in a model that would be used to predict license sales in 2002 data on participation by anglers more than one generation prior. The analysis was limited to resident, non-senior licenses, which consistently account for 87–89% of all license sales. Senior annual licenses are difficult to model because of the attrition process as anglers buy lifetime licenses. An analysis of non-resident license sales is complicated by the recent introduction of 3- and 7-day tourist licenses.

Resident license sales increased steadily during the 1970s and 1980s from 695,000 in 1970 to 1,015,000 in 1990, but declined during the 1990s, to 838,000 in 2001.[1] To control for changes in population over the period, the dependent variable in the analysis was the number of licenses sold in each year divided by the number of Pennsylvania residents between the ages of 16 and 64, a measure of licenses sold per capita.

The explanatory variables used in the analysis included real (deflated) license price, the unemployment rate (×100), average real per-capita personal income, and the number of adult trout stocked in Pennsylvania. License price includes issuing fees, as well as the cost of a trout stamp. Although not all license holders purchase a trout stamp, the majority (68–73%) do. The unemployment rate was included as a measure of the opportunity cost of time, because anglers have reported that the amount of free time they have is an important determinant of participation in angling. Over the study period, the number of adult trout stocked increased from 2.7 million fish in 1970 to over 5 million by the mid 1980s, and then held fairly consistent between 5 million and 5.3 million through the 1990s.

Unit root tests (both augmented Dickie-Fuller and Phillips-Perron) showed that the time series for licenses sales per capita and for each of the explanatory variables were non-stationary. Ordinary regression of license sales on the explanatory variables would therefore lead to spurious results. Instead, regressions were conducted using first-differenced data. Unit root tests rejected non-statationarity (at the 1% level) for all first-differenced variables. The dependent variable in the regressions was the absolute change in per capita licenses sales (positive or negative) that occurred each year, relative to the year before. The explanatory variables were first-differenced as well (change in real price, change in unemployment, change in income, and change in stocking rate). Additional regressions were estimated that included lagged changes in the stocking rate, to determine whether it takes time for anglers to learn about changes in fishing quality. A trend variable was added to the regression to detect changes in the underlying rate of change in license sales. Models with moving average and autoregressive error structures were estimated. Maximum likelihood regressions and projections of license sales in 2002 were estimated using the SAS ARIMA procedure.

[1]USFWS national estimates of fishing license sales also showed a pattern of increasing sales during the 1970s and 1980s, and a decline during the 1990s, although the percent changes were smaller than in Pennsylvania.

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Survey of Resident Trout Anglers

A telephone survey of Pennsylvania trout anglers was conducted during the first half of September 2001. Sampling was done by randomly selecting license application forms. Telephone interviews were conducted by Responsive Management, Inc.

Respondents were first asked a series of questions about their fishing experience, including how many years they had fished, how often they fished, how many fish they caught per trip (on average), what type of gear they used, whether they targeted stocked fish or wild fish, and their rating of the quality of the fishing experience in Pennsylvania. In order to estimate the background rate of entry and exit in the fishery, they were asked whether they had bought a license in 2000, and whether they intended to purchase a license and/or stamp in 2002. If they intended to leave the fishery in 2002, they were asked their reason for exit.

Respondents were then told that fewer trout would be stocked in 2002 than in 2001. Respondents were asked to imagine that the reduction in trout stocking would be 1 of 3 levels: 10%, 30%, or 50%. Each respondent was randomly assigned one reduction level. (Later in the interview, respondents were told that the actual planned reduction is 28%, which is the reduction that actually occurred in 2002.) Respondents were asked whether the specified reduction in the number of trout stocked would make trout fishing more enjoyable or less enjoyable for them and whether they still would buy a license and stamp if stocking levels were reduced by the specified amount.[2] Logistic regression was used to model the proportion of anglers who would stop buying trout stamps, and the proportion of anglers who would stop buying licenses, as a function of the stocking level decrease. Based on these logistic regressions, the changes in license and stamp sales due to the stocking decrease were estimated. Incorporating the background rates of entry and exit, projections of the change in license and stamp sales were generated.

Results

Econometric Analysis of Historical License Sales

To determine whether the error structure in the first differenced model showed serial correlation, both moving average (MA) and autoregressive (AR) models were estimated. A model estimated with a MA(1) error structure showed significant serial correlation, whereas a model with an AR(1) error structure did not. In a model with both MA(1) and AR(1) structures, the estimated parameter for the former was significant at the 10% level, whereas the estimated parameter for the latter was not. The authors conclude that a model with an MA(1) structure is appropriate.

Regression results from the econometric analysis of historical license sales are shown in Table 1. The dependent variable was the annual change in resident licenses sold per capita. The regression explained 78.4% of the variance in the dependent variable. The regression standard error was 0.002118.

The constant term and the trend term work together to determine the background level of change in license sales. The trend term was set so that it equals 0 in 1970. Thus, in the

[2]The specific wording of the question was "Suppose that X% fewer trout are going to be stocked next year than this year. Would you still buy both a fishing license and a trout stamp for 2002?" with X = 10, 30, or 50. A follow-up question identified respondents who would buy a license but not a stamp.

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Table 1
Regression Results for Resident License Sales

Variable	Estimated coefficient	Std. error	*t*-Statistic
Constant	0.002146	0.001155	1.86*
Trend	–0.000124	6.21E-05	–2.00**
Trout stocked	–9.715E-11	1.05E-09	–0.09
License price	–0.001703	0.000143	–11.88***
Unemployment	0.000972	0.000369	2.64***
MA(1) coefficient	–0.4685	0.184384	2.38**

* Significance level ≤ 0.10; ** Significance level ≤ 0.05; *** Significance level ≤ 0.01.

early part of the period 1970–2001, the background trend was positive—absent any change in price or unemployment, license sales tended to increase. In later years, the background trend turned negative.

Real per capita income was not a significant determinant of license sales, and was dropped from the regression.

Price was an important determinant of license sales. For each $1 increase in the real price of a fishing license, resident license sales per capita dropped by 0.001703. In 2001, when the population of Pennsylvania between the ages of 16 and 64 was 7,838,000,[3] this would translate into a decrease of 13,350 resident licenses. Expressed as a point elasticity, a 1% increase in the real price of a fishing license would result in a 0.36% decrease in resident licenses sales. This is larger than that found by Teisl et al. (1999) but smaller than that found by Sutton et al. (2001).

Unemployment was also a significant determinant of license sales, with higher unemployment leading to higher license sales. The magnitude of the effect was less than for price changes. A one-point increase in the unemployment rate would result in an increase in resident license sales of 7,620, an increase of 0.9%.

The number of adult trout stocked was not a significant determinant of resident license sales, as evidenced by the low *t*-statistic on this explanatory variable. This nonresult held regardless of whether a trend variable was included in the regression, so it cannot be attributed to colinearity with the trend variable. Nor did the result change when the regression was run with longer lags, up to a four-year lag, so there does not appear to be a learning effect. Nor did the result change when biomass of fish stocked was used, instead of number of fish. From the 32 years of data used for the analysis, there is no statistical evidence that stocking rate influences license sales.

To summarize, the econometric analysis of historical license data showed that license price and the unemployment rate were significant determinants of license sales, but that the number of trout stocked each year was not. To determine the level of uncertainty associated with the result regarding stocking levels, the authors calculated the impact that a 1.4 million fish decrease in stocking would have on resident license sales and a confidence interval for that impact. Because the estimated coefficient for trout stocked was negative, the expected impact of the stocking decrease was an increase in license sales of 1,070 licenses, or 0.1%. Although the predicted impact on license sales was essentially zero, the

[3]Based on linear interpolation between data from 2000 census and PA State Data Center's July 1, 2002 population estimate.

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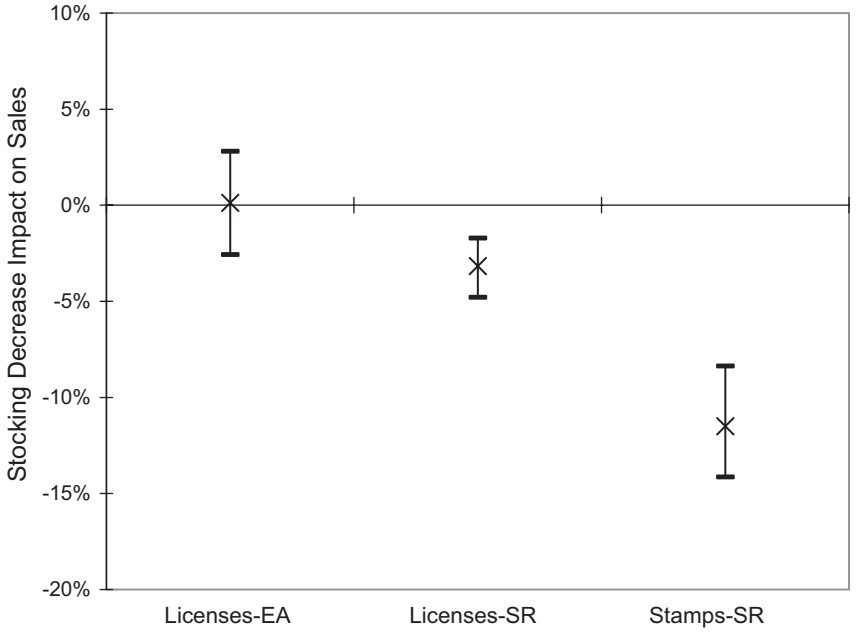

Figure 1. Impact of stocking decrease on license and trout stamp sales (EA = Econometric Analysis, SR = Survey Responses). Vertical bars show 95% confidence intervals.

uncertainty associated with this prediction was high. Figure 1 shows a 95% confidence interval for the impact of the stocking decrease in resident license sales.

Survey Responses

A total of 611 angler interviews were completed, of which 600 held regular annual resident licenses. The remaining 11 held senior annual resident licenses, and were excluded from the analysis. All had purchased trout stamps for the 2001 season. The survey unit response rate was 62.3% (total completed interviews/total attempted interviews, excluding ineligible contacts). The average angler in the sample was 43 years old, and had been fishing for 27 years. Ninety-three percent of respondents were male. The median respondent fished for trout on 10 days in 2001.

Of anglers who purchased a resident license and trout stamp in 2001, 1.3% stated that they did not intend to purchase a license in 2002. An additional 2.6% stated that they intended to purchase a license, but not a stamp. Of anglers who purchased a license and stamp in 2001, 0.8% did not purchase a license in 2000. An additional 0.3% purchased a license, but did not purchase a trout stamp in 2000.[4] Based on these background rates of entry and exit, there is an expectation of a net decrease in license sales of 0.5% and a net decrease in stamp sales of 2.8% between 2001 and 2002 without any change in stocking levels.

The 25 respondents who stated that they planned to stop fishing for trout in 2002 were asked their reasons why. The most common reason given was poor quality of fishing. The second most common reason was poor water quality or contaminants in the fish. Four of

[4]Item non-response rates were 0.2% for the question regarding plans for 2002, and 1.3% for the question regarding license purchase in 2000.

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Table 2
Logistic Regression of Dropout Rates

Coefficient	Will stop buying license	Will stop buying stamp
Intercept	2.8208	1.6859
	(0.4414)***	(0.2374)***
1/Stocking Decrease	0.1674	0.0993
	(0.955)*	(0.0437)**
Sample Size	586	586
Model χ^2 (1 d.f.)	3.8857	5.6822

* Significance level ≤ 0.10; ** Significance level ≤ 0.05; *** Significance level ≤ 0.01.

the 25 mentioned license cost as a factor. The question was asked before respondents were told about planned changes in the stocking program, and only one angler mentioned the planned decrease as a reason for quitting trout angling. The remaining analyses included only those anglers who planned to fish for trout in 2002.

Anglers were asked what impact a decrease in stocking would have on their enjoyment from trout fishing. At all three described stocking reduction levels, the most common response was that the decrease would have no impact on enjoyment. Although a few respondents stated that a decrease in stocking would increase their fishing enjoyment, far more said that the reduction would decrease their enjoyment.

Combining all responses, 7.5% of respondents stated that they would stop buying a trout stamp, but would continue to fish, in response to the stocking decrease. An additional 2.7% stated that they would stop fishing entirely.[5] Logistic regressions were estimated to model the proportion of anglers who would discontinue buying licenses and stamps as a function of the stocking decrease. The specific explanatory variable used in the logistic regression was the inverse of the percent stocking decrease. Using this form of the logistic model, the drop-out rate (DOR) is given by

$$DOR(SD) = \frac{1}{1 + \exp\left[\alpha + \beta / SD\right]} \tag{1}$$

where *SD* is the percent stocking decrease. This form provided a better fit than a linear logistic model (as measured by the model log likelihood), and is consistent with the theoretical expectation that, in the limit, a stocking decrease of 0% results in a drop-out rate of 0%.

The estimated coefficients of these logistic regressions are given in Table 2. The estimated coefficients on the stocking level measure were of the expected sign, and were statistically significant at the 10% level or lower, indicating that the stated dropout rate was higher for larger stocking decreases. Based on these logistic regressions, a 28% reduction in the number of trout stocked would result in a predicted 3.2% decrease in resident license sales and an 11.5% decrease in trout stamp sales. These predicted impacts, along with 95% confidence intervals, are shown in Figure 1.[6]

[5]Item nonresponse for this question was 0.3%.

[6]Confidence intervals for these predictions are generated using Monte Carlo techniques (Krinsky & Robb, 1986).

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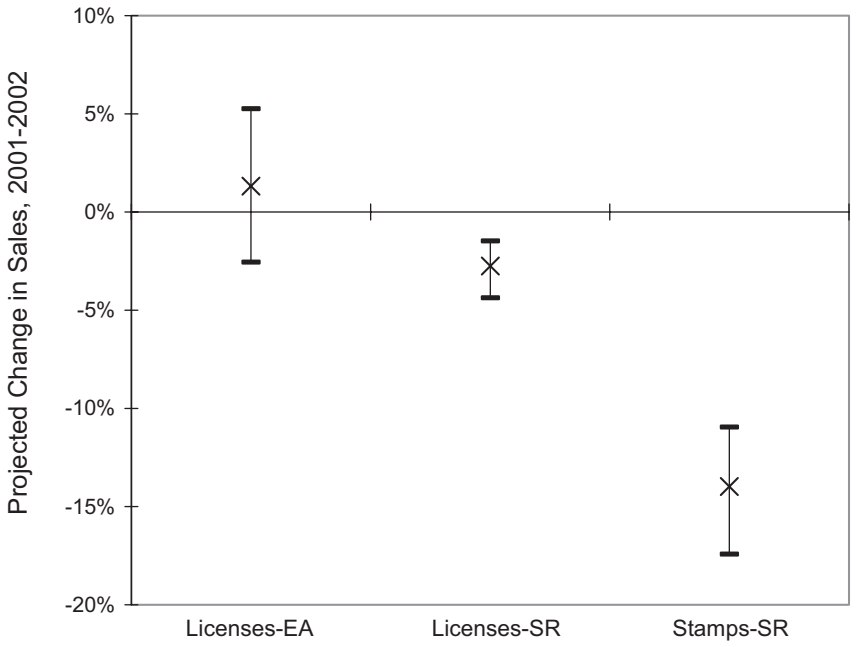

Figure 2. Projected change in license and trout stamp sales, 2001–2002. Vertical bars show 95% confidence intervals.

Predicting License and Stamp Sales

Figure 1 shows the estimated impact of the stocking decrease on license and stamp sales, but does not take into account other factors that affect license sales over time. License sales in 2002 were predicted using all information available in 2001 based on the econometric analysis and the survey responses.

Absent any change in fish stocking practices, the econometric model predicted that resident license sales would increase by 1.2% between 2001 and 2002. This included the combined effects of five influences. The first is the background rate of entry and exit captured by the model intercept and trend terms. Second, the unemployment rate increased between 2001 and 2002 by 1 percentage point. Third, inflation caused the real price of a license and stamp to decrease by $0.25.[7] Fourth, license sales in 2001 were higher than the model predicted. Because sales changes are serially correlated through a moving average process, this implies a higher-than-normal license sales change for 2002. Fifth, the population of Pennsylvania residents between the ages of 16 and 65 increased by 0.8%.

The total predicted change in license sales was this 1.2% increase plus the impact of the stocking decrease. The resulting projected change in license sales is shown in Figure 2. Although the econometric analysis predicted a small (1.3%) increase in license sales, the 95% confidence interval for this projection was wide (–2.5%, 5.3%).[8]

[7] In practice, the analyst would not have advanced knowledge of the unemployment or inflation rate, and would have to rely on projections of those underlying economic variables.

[8] The license sales projection from the econometric analysis and its confidence interval were calculated using the SAS ARIMA procedure.

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Next, license and stamps sales were projected based on the survey responses. It was assumed that only trout anglers would change their behavior in response to the stocking change. Absent any stocking decrease, the survey responses implied that resident license sales in 2002 would be 0.5% lower than in 2001, and trout stamps sales would decrease by 2.8%. Adding the impacts of a stocking decrease gave a projected decrease in resident license sales of 2.7% with a 95% confidence interval of (–4.4%, –1.5%), and a projected decrease in trout stamp sales of 14.0%, with a 95% confidence interval of (–17.4%, –10.9%).[9] These are shown graphically in Figure 2.

Comparison to Actual Sales

Actual reported sales in 2002 showed that resident license sales were 4.2% lower than in 2001. Trout stamps sales were 4.5% lower than in 2001. The observed decrease in resident license sales falls outside the 95% confidence interval for the projection based on the econometric analysis of historical license sales, but falls within the 95% confidence interval for the projection based on the survey responses. However, the observed decrease in stamp sales was much less than that predicted from the survey responses, and falls outside the 95% confidence interval for that projection.

Before examining the predictive performance of the econometric analysis and the survey responses, it is helpful to consider whether the change in license sales observed between 2001 and 2002 was, at least in part, due to the decrease in trout stocking. It is impossible to answer this conclusively based on just one year's sales, but a 4.2% year-to-year decrease in resident license sales is an unusual event. Since the end of World War II, there had never previously been a year-to-year decrease that large in a year without a price increase. Similarly, since trout stamps were introduced in 1991, the largest year-to-year decrease in stamp sales in a year without a price increase was 1.8%. The decrease in stocking in 2002 was very well publicized prior to the opening of the 2002 fishing season. The authors know of no other external factor that could explain the observed decrease in license sales.

Discussion

There is a presumption in the literature on nonmarket valuation that revealed (past) behavior is a better source of information than stated behavior intentions, when the goal is to predict future behavior (Bishop, 2003). However, history may not provide natural experiments with enough variation in the explanatory variables to estimate precise models. The present econometric analysis is based on 32 years of data, during which time trout stocking increased roughly two-fold, and license fees increased five times. That period apparently contained enough variation in license fees to identify their impact on license sales, but not enough variation in trout stocking to identify its impact on sales.

The survey responses gave a more precise projection of the impact of a change in trout stocking on license sales, and also provided a projection of the impact on stamp sales, something an econometric analysis of historical sales could not do (stamps have only been sold since 1991). However, the reliability of projections based on stated behavior

[9]Confidence intervals for the license and stamp sales projections from the survey responses include two sources of uncertainty, the sampling variances of the baseline rates of entry and exit, and the sampling variance of parameters of the logistic regressions from Table 2. The combined effect of these two sources of uncertainty was simulated using Monte Carlo techniques.

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intentions depends on the respondents' ability to accurately predict their own behavior (at least on average) and their willingness to truthfully report their intentions.

Both of these assumptions are suspect. An angler who preferred less of a decrease in stocking, but who planned to fish regardless, could send a signal to the PFBC of their preferences by stating an intention to quit the sport. The respondent may have believed that such a strategic response might induce the PFBC to lessen the planned stocking decrease. Because fishing license fees for 2002 were already set at the time of the survey, this would have had no cost to the respondent.

Even if the respondent attempted to answer truthfully, he may have systematically over- or under-stated the likelihood of quitting trout fishing in 2002. A statement that the respondent intends to do something (like quit fishing) is not a perfect predictor of that respondent's behavior. This has been seen in both marketing research, where stated purchase intentions are compared to actual purchase behavior (Day, Gan, Gendall, & Esslemont, 1991) and in contingent valuation studies, where stated intentions to pay for a public good are compared to actual payment behavior (Harrison & Rutström, 2005). These studies have found that respondents often overstate the likelihood that they will purchase the market good or pay for the public good.

What implications does hypothetical bias have for the survey-based projection in this study? If the marketing and CV study results are interpreted as meaning that survey respondents may tend to overstate their willingness to pay for things (in this case for a fishing license and stamp), then stated behavior will overpredict the number of anglers who buy the license and stamp. If, however, those findings are interpreted as meaning that survey respondents may tend to overstate their propensity to change from a status quo situation, and it is assumed that the status quo situation for trout anglers is to buy a license and a stamp, then the marketing and contingent valuation results would suggest that the survey respondents may overstate the likelihood that they will cease buying a license and stamp in response to the change in fishing quality.

There are, then, two different projections of the impact of a stocking decrease on license and stamp sales—one based on revealed preferences that has rather low predictive precision (a wide confidence interval), the other based on stated preferences that has better predictive precision, but that may be biased. In this case, neither approach proved uniformly better. The econometric analysis based on revealed behavior failed to detect a relationship between trout stocking rates and license sales that appears to exist, and underpredicted the decline in license sales. The stated behavior projections predicted the decrease in license sales with fair accuracy and precision, but overpredicted the number of anglers who would stop buying a stamp. This last result is consistent with the results of a study by Loomis, Pierce, and Manfredo (2000). They found that Colorado hunters overstated the rate at which they would discontinue purchasing hunting licenses in response to a fee increase.

One limitation of this study is that it assumes that anglers make license purchase decisions with full knowledge of that season's planned stocking program. Although the stocking decrease was well publicized prior to the 2002 season, it may take time for some anglers to realize that the quality of the fishery has changed, either through their own fishing experiences, discussions with other anglers, or through the media, although the econometric analysis showed no evidence of a lagged relationship between stocking and license sales. It is of interest to note that even though stocking levels rebounded slightly in 2003, license and stamp sales decreased further. However, the two-year decrease in stamp sales (7.1%) was still smaller than the one-year decrease predicted by the survey responses.

The authors were fortunate in this study that the change in stocking in 2002 was of the magnitude that had been projected, and was not accompanied by any other major program

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changes, such as a fee increase. This allowed direct comparison between the projections of license and stamp sales and actual sales. In a study of pheasant hunting in Oregon (Berrens & Adams, 1998), a comparison between stated preference projections and actual participation was complicated because the hunting program that was implemented differed from the program evaluated in the survey. The present survey was designed with three different stocking level decreases, to accommodate unanticipated changes in how the decrease was implemented.

It is concluded that both revealed preference and stated preference approaches have some utility in projecting changes in license sales. The stated preference approach identified a link between stocking rates and participation that the revealed preference approach failed to identify. Still, statements of intention to change behavior must be interpreted cautiously. Recreationists may overstate their propensity to change their recreation behavior in response to a quality change. A comparison of revealed preference and stated preference projections can highlight possibly unrealistic predicted changes in behavior.

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