Contingent Valuation of a Public Program to Control Black Flies

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Contingent valuation is used to measure the benefits of a proposed public program to control black flies. Respondents' reported values are analyzed from three perspectives: data outliers, consistency between respondents' reported values and their perceptions of black flies, and the temporal reliability of the values expressed by respondents. The results suggest that the estimated contingent values are plausible even though a majority of respondents expressed a value of zero dollars for the black fly control program.

Introduction

Black flies are a major pest in many areas of the northeastern U.S., Canada and other countries around the world. Although black flies are not disease carriers in the U.S., their bites are painful and can cause allergic reactions for some people. The swarming action of black flies is also a nuisance. In severe situations, black flies can significantly limit outdoor activities during periods of high infestation.

Some states, such as Pennsylvania, have on-going programs to control black flies. Other states, including Maine, New Hampshire and New York, have conducted experimental control programs. Experimental control programs in Maine have been conducted on the Carrabassett River and a tributary stream in the Sugarloaf area (Gibbs, *et al.*, 1986). Evaluations of these programs have focused on the biological aspects of control; some work also has been done to estimate costs of control. However, to our knowledge, no studies have estimated the benefits of control.

The research reported in this paper uses contingent valuation to estimate the benefits of a proposed black fly control program along the Penobscot River in Maine. Since contingent valuation has not been used previously to estimate the benefits of black fly control, the validity and reliability of the estimated values are investigated. Specifically, the contingent values are examined in terms of data outliers, the consistency between reported values and respondents' perceptions of black flies, and the temporal reliability of the values expressed by survey respondents.

Black Fly Control in Maine

Black flies inhabit rivers and streams during the larval stage, and control efforts are usually directed at controlling black flies while they are concentrated in these bodies of water. The most common method of control involves the use of the biological insecticide *Bacillus thuringiensis* var. *israeliensis*, or *Bti*, which is introduced into the river or stream by aerial application or by releasing it at bridges and other access points along a stream.

Although many species of black flies exist in Maine (Bauer and Granett, 1979), they can generally be divided into two types: early-season and late-season varieties. Early-season black flies appear in early spring and disappear in late June or early July; late-season varieties emerge in July and disappear in late Septem-

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ber or October. Early-season black flies occur throughout the state, thus making any type of control problematic. Late-season varieties, in contrast, are more amenable to control since they primarily exist in only one geographic region of the state, along the Penobscot River. Thus, control benefits for a late-season black fly control program were estimated for residents of communities along a thirty-mile stretch of the river between the towns of Millinocket and Howland.

Methodology

Contingent valuation was selected for use in the study due to its ability to measure benefits of a public good such as controlling black flies, and its growing acceptance as a method for measuring such benefits (Cummings, Brookshire and Schulze, 1986; and Mitchell and Carson, 1989). Other methods of nonmarket valuation are too narrow in scope to estimate the benefits of the proposed control program (Reiling *et al.*, 1988). Furthermore, contingent valuation has been used successfully to evaluate the benefits associated with mosquito control programs (John, Stoll and Olson, 1987; and Ofiara and Allison, 1985) and the aesthetic benefits of Gypsy Moth control (Voorhees, 1980).

The values associated with the proposed black fly control program were measured using maximum willingness to pay, or the maximum dollar amount respondents would be willing to pay to make them indifferent between having the control program and not having it. Value statements were elicited from heads of households and were expressed as maximum values per household per year.

All respondents were asked to evaluate three levels of control: 60, 75, and 90 percent reductions in the number of late-season black flies. Three levels of control were evaluated for two reasons. First, a control program has not been implemented in the study area, so the exact level of control that can be achieved is unknown. Variables such as water volume, water temperature and the flow characteristics of the river at the time of application of the insecticide can affect the efficacy of control. Second, the level of control can vary significantly from site to site within the study area, due to factors such as the distance from the river to population centers.

Procedures

For the purposes of the study, the household was chosen as the unit of observation. Ideally, the population of interest is all households that reside in the towns adjacent to the Penobscot River between Millinocket and Howland. However, the sample was selected on the basis of the zip codes served by the post offices located in the communities adjacent to the river. Consequently, the study area includes some towns and unorganized areas that are not adjacent to the Penobscot River. However, this is not considered to be a serious problem since the number of households in the towns that are not adjacent to the river account for less than two percent of the 7,836 households residing in the study area.

A randomly-selected sample of 694 households, representing about nine percent of the total number of households in the study area, received questionnaires. The sample was divided into two equal groups of 347 households. The first group was surveyed during the occurrence of late-season black flies in August and September of 1987 and the second group was surveyed after the late season (late October and November). The two groups were surveyed in different time periods to test the temporal reliability of the contingent values reported by respondents.

A total of 224 completed questonnaires were returned by the households surveyed during the black fly season. Forty-five questionnaires, or 13 percent, were not deliverable. Hence, the response rate for this group was 74 percent (224 of the 302 deliverable questionnaires). The response rate for the households surveyed after the season was slightly lower, 69 percent. Forty-four of the 347 questionnaires were not deliverable, and 209 of the 303 deliverable questionnaires were completed and returned. Overall, 433 questionnaires were returned, yielding an overall response rate of 72 percent.

Since respondents did not have experience with an organized public program to control black flies, the survey instrument was carefully designed to insure that respondents were fully aware of the nature of the proposed control program and the payment vehicle by which they could express their statements of maximum willingness to pay. The black fly control program was described to respondents in the following manner:

As noted above, *late season* black flies exist during the months of July, August and September. Most of the species of *late season* black flies both bite and swarm around people. The control program, if implemented, would be designed to reduce the number of black flies that exist in July, August and early September. *The control program would have no effect on the number of black flies that exist in May and June each year.*

The most likely control program for *late season* black flies would involve the aerial application of the biological insecticide *Bti* into the Penobscot River every ten days throughout the months of July, August and September. The introduction of *Bti* into the water only affects black fly and some midge larvae. The introduction of *Bti* is not expected to have undesirable environmental effects on fish and other aquatic organisms. *Bti* is used to control black flies in other locations, including New York; New Hampshire; Pennsylvania; and Labrador, Canada. No undesirable environmental effects have been reported from the use of *Bti* to control black flies in these areas.

The description of the payment vehicle was presented to respondents as follows:

Suppose a special district that included all the towns along the Penobscot River between Millinocket and Howland was established to control *late season* black flies. The sole purpose of the district would be to raise revenue to pay the costs of this *late season* black fly control program. Residents of these towns along the Penobscot River would be the people who benefit directly from the reduction in the number of *late season* black flies. *All residents of the area* would be required to pay an annual fee to this district to cover the costs of the *late season* black fly control program. All revenue would be used for the *late season* black fly control program. This special district is *not* being proposed, but is being used as a way for us to discuss the value you attach to the control of *late season* black flies in your area.

Note that the payment vehicle used consisted of a special control district that included all the towns in the study area. Since the sample represented all households in the affected communities, this payment vehicle was chosen to be realistic to renters as well as homeowners. In addition, this payment vehicle was also selected to avoid adverse reactions associated with using a tax increase as the procedure for eliciting statements of maximum willingness to pay.

An open-ended question was used to elicit statements of maximum willingness to pay. The question for the 60 percent level of control was:

Please indicate the *maximum annual fee* that your household would pay to this district to reduce the number of *late season* black flies in your area by *sixty* (60) percent. (NOTE: if you would not pay anything to the district to reduce *late season* black flies by 60 percent, please place a *zero* ($0) in the space below).

$___ Maximum annual fee my household would pay for a *60 percent* reduction in *late season* black flies.

The questions for the 75 and 90 percent control levels were identical to this question, except all references to the 60 percent control level were replaced with 75 percent and 90 percent, respectively.

Results

Estimated values for the three levels of control present some interesting comparisons (Table 1). The mode for all three groups is zero dollars, indicating that a majority of respondents are unwilling to pay any positive amount for the levels of control evaluated. Note, however, that some respondents switched from bidding zero dollars to stating a positive value when the level of control reached 90 percent. Furthermore, the estimated mean values increase with the level of control; the means for both the 60 and 75 percent control levels and for the 75 and 90 percent control levels are statistically different at

Table 1. Maximum Annual Values Per Household for Late-Season Black Fly Control

	Percent Stating Dollar Amounts Within Categories		
Maximum Annual Value	60 Percent Control (n = 383)	75 Percent Control (n = 383)	90 Percent Control[b] (n = 394)
$0	69	68	60
$1–$10	16	10	11
$11–$20	5	8	7
$21–$30	4	6	9
$31–$40	0	1	3
$41–$50	3	2	4
$51–$60	1	1	1
$61–$70	0	0	0
$71–$80	1	2	1
$81–$90	0	0	1
$91–$100	1	1	3
$101 and greater	0	1	1
MEAN	$7.60 (1.03)[a]	$9.61 (1.26)	$15.13 (1.85)

[a] Standard errors are presented in parentheses.
[b] Column percentage does not add to 100 due to rounding.

the 0.10 level of significance. Conducting these tests assumes that respondents' answers to the different levels of control are independent. This assumption is somewhat tenuous since each respondent evaluated all three levels of control; consequently, results of the statistical tests should be interpreted with caution.

Since respondents did not have experience with a black fly control program, and black fly control is a new application of contingent valuation, the study was designed to allow further investigation of respondents' statements of maximum willingness to pay. These additional design features were fortuitous given the large number of respondents who stated a value of zero dollars for all three levels of control. Considering the results from a referendum perspective, where each person has one vote, black fly control would not be approved by voters. Thus, from a welfare economics perspective, where the importance of an individual's "vote" is measured in dollars, it is critical to investigate the validity and reliability of responses to the contingent valuation responses. Such an investigation can be accomplished using a variety of procedures. The valuation responses were examined from three different, but related, perspectives: data outliers, consistency of value statements with respondent's perceptions of black flies, and temporal reliability.

Data Outliers

Two approaches were used to identify potential outliers in the responses to the valuation questions for the 90 percent level of control. One approach focuses on identifying outliers by having respondents indicate why they provided their specific response to the contingent valuation question. The second approach is based upon a statistical test for outliers that was employed in a contingent-valuation study by Desvousges, Smith and Fisher (1987).

Identifying data outliers by having respondents reveal why they stated a value of a certain amount is often referred to as identifying "protest" or invalid responses. Strategic behavior and free riding are two traditional motivations that may yield outliers in contingent-valuation data sets. Alternatively, some respondents may give invalid responses to protest the payment vehicle or some other aspect of the contingent-valuation exercise. Outliers may also occur if respondents do not fully understand the valuation procedures or the scenario being evaluated. These are a few examples of the many factors that can cause outliers in contingent-valuation data. Although there is evidence that strategic behavior and free riding may not be serious problems (Mitchell and Carson, 1989), further investigation of responses is often warranted, especially when more than 50 percent of the valuation responses are equal to zero, as in this study.

To identify outliers associated with protest responses, respondents were asked to indicate the reason why they stated a maximum willingness to pay of zero dollars or, alternatively, the reason they stated a positive dollar value. These questions were asked immediately after respondents had answered the contingent valuation question for the 90 percent level of control. A series of fixed response categories were presented along with an open-ended category for use if a respondent's reason did not fit one of the specified categories. Respondents who chose the open-ended category were also asked to state their reason for the value given and their written reasons were used to classify responses as being "protest" or "not protest" valuations. Such an approach has been used in other contingent valuation studies (Boyle and Bishop, 1988; and Desvousges, Smith and McGivney, 1983).

Respondents were presented somewhat different reasons for their expressed values depending upon whether they stated a value of zero dollars or a positive value. The categories presented to those who stated a positive value are presented in Table 2. Reasons 4, 5, and 7 were classified as protest responses. Although it is tempting to classify item 6 as a protest response, this was not done because it was impossible to completely assure respondents that the proposed control program would not have adverse environmental impacts. Based on these procedures, 11 percent of the positive dollar responses were considered to be protest responses.

For those stating a value of zero, reasons 5, 6, 8 and 9 in Table 3 were classified as protest responses. Hence, 24 percent of the responses of zero dollars were classified as protest responses. Based on the same logic as applied to reason 6 in Table 2, reason 7 was not included as a protest response. Reason 4 in Table 3 might also be considered a protest category.

Table 2. Reasons Respondents Stated a Maximum Willingness to Pay Greater Than $0 for 90 Percent Control

Reason	Percent Responding[a]
1. Stated my best guess	37
2. Most I can afford	21
3. Maximum value I place on control	9
4. Overstated value to increase chance of control	7
5. Understated value because others will pay	3
6. Understated value due to environmental concerns	3
7. Understated value to reduce cost of control	1
8. Other—Some type of protest response	0
9. Other—Not a protest response	18

[a] Percentages do not add to 100 due to rounding.

However, it was not classified as a protest response because there are also reasons why it may represent a legitimate response.

After identifying the protest responses, those observations were omitted from the data set and sample statistics were re-calculated. The new response distributions are shown in Table 4. These distributions are quite similar to the original distributions, and the means increase with the level of control. More interestingly, the omission of protest responses had almost no effect on the overall means. Statistical tests to identify significant differences were not conducted because the two samples are not independent.

Table 3. Reasons Respondents Stated a Maximum Willingness to Pay of $0 for 90 Percent Control

Reason	Percent Responding
1. Stated my best guess	7
2. I cannot afford to pay anything	22
3. I do not want black flies controlled	3
4. I do not have enough information	3
5. I do not believe black flies can be controlled	4
6. I believe others will pay	0
7. I am concerned about environmental effects	11
8. I don't like the idea of a special control district	11
9. Other—Some type of protest response	9
10. Other—Not a protest response	30

Table 4. Maximum Annual Values Per Household for Late-Season Black Fly Control with "Protest" Responses Omitted

	Percent Stating Dollar Amounts Within Categories		
Maximum Annual Value	60 Percent Control[a] (n = 310)	75 Percent Control[a] (n = 310)	90 Percent Control (n = 321)
$0	66	66	57
$1–$10	18	11	12
$11–$20	5	9	7
$21–$30	5	6	10
$31–$40	0	1	3
$41–$50	3	3	4
$51–$60	1	1	1
$61–$70	0	0	0
$71–$80	1	1	2
$81–$90	0	0	1
$91–$100	0	1	3
$101 and greater	0	0	1
MEAN	$7.61 (1.12)[b]	$9.61 (1.36)	$15.61 (2.09)

[a] Column percentage does not add to 100 due to rounding.
[b] Standard errors are presented in parentheses.

The above procedure for identifying outliers has a number of problems, with two issues of major concern. First, if respondents knowingly misstate their values, they probably will not tell the researcher that they are doing so. Second, not all outliers are the result of conscious motivations. An alternative that would help to resolve these problems would be to use a statistical procedure to identify outliers that is not based solely on respondents' stated reasons for their response to the contingent valuation question. Thus, a statistical procedure employed by Desvousges, Smith and Fisher (1987) was used to search for outliers in the responses to the 90 percent control level.

Using the regression reported in the next section (Table 5), observations were deleted one at a time from the data and the regression coefficients were reestimated. Desvousges, Smith and Fisher classified observations as protests if the coefficient on the income variable in their equation changed by 30 percent, or more, when the observation was deleted from the data. It is important to note that there is nothing magical in using the coefficient on income to identify protest responses, nor does a 30 percent change in the estimated coefficient represent a hard and fast decision rule. Using the coefficient on the income variable does, however, have intuitive appeal when identifying outliers in contingent-valuation data because income would be included in any theoretical value definition. For purpose of this present study, changes in the coefficient on income were used for this reason and two other practical reasons. First income is the only significant nonbinary variable in the equation reported in Table 5, and the second reason is that it facilitates comparisons of the results of the application with the findings from the Desvousges study.

With respect to a decision rule for identifying outliers, we examined the calculated percentage changes in the coefficient on income to identify natural breaks in the distribution of these derived deviations. The mean percentage change in the income coefficient, across deletions of all observations, is 0.002 percent with a standard error of 2.5 percent. Only four observations resulted in a calculated percentage change exceeding two standard deviations of this mean, and these percentage changes, in absolute values, are 5.6, 5.2, 39.0 and 6.2 percent. Thus, one can see that removing observations from the data did not have a substantial effect on the estimated income coefficient. However, we classified the observation resulting in the 39 percent change as an outlier.

The respondent that created the 39 percent change in the income coefficient stated maximum willingness' to pay of \$250, \$300, and \$500, respectively, for the 60, 75, and 90 percent levels of control. These bids represent the highest valuations reported for each level of control. Removing this observation from the data set reduced estimated means to \$6.97, \$8.85 and \$13.90, or the means reported in Table 1 are reduced by \$0.63, \$0.76 and \$1.23. Hence, this observation had a fairly large impact on the estimated values. It is also interesting to note that this observation was not identified as a protest response using the direct questioning procedure described above. The respondent's answer to the direct questioning procedure was that they stated their best guess. Furthermore, examining the survey booklet of this respondent does not yield any evidence as to whether this respondent was, or was not, responding truthfully to the valuation questions. Hence, even though this observation is an outlier in the statistical sense, the reported values may be an accurate representation of the household's willingness to pay for black fly control.

These two procedures both indicate that the contingent-valuation data do not contain a large number of outliers despite the fact that more than half of the values expressed by respondents are equal to zero dollars. Contingent-valuation data do need to be examined for outliers, even if the actual number may be very small. Such examinations, however, re-

Table 5. Tobit Estimates of Regression Coefficients

Variable	β_j	$\Phi(\cdot)$	$\partial E(Y)/\partial x_j$
Intercept	−65.08*[a]	—	—
	(14.65)[b]		
Black Fly Most Bothersome Biting Insect (= 1)	25.55*	0.47[c]	12.01
	(8.34)		
Late or Early/Late Season Most Bothersome (= 1)	16.32	0.43[c]	7.02
	(11.85)		
Use Self Protection (= 1)	−27.62*	0.23[c]	−6.35
	(13.31)		
Medical Attention Required by Household Members (= 1)	27.72*	0.62[c]	17.19
	(13.23)		
Household Size	1.54	0.41[d]	0.63
	(2.62)		
Household Income	0.001*	0.41[d]	0.00
	(0.000)		
Miles from River to Residence	−1.13	0.41[d]	−0.46
	(1.17)		
$\chi^2(8)$	47.46	—	—
N	321	—	—

[a] An asterisk denotes significance at the 0.10 level.
[b] Asymptotic standard errors are reported in parentheses.
[c] $\Phi(\beta' x_i/\sigma | x_j = 1 \text{ and } x_k = \bar{x}_k)$ for $j \neq k$, where $\bar{x}_k$ = sample mean of variable k.
[d] $\Phi(\beta' x_i/\sigma | x_j = \bar{x}_j)$ for $j = 1, 2, \ldots, 7$.

quire careful subjective decisions on the part of a researcher since no hard and fast theoretical or statistical rules exist for removing contingent-valuation responses from a data set.

Consistency of Value Statements with Perceptions of Black Flies

Respondents were asked a number of questions about their perceptions of black flies and how black flies affect them. All other factors being equal, one would hypothesize that respondents who consider black flies to be problematic would also express higher values for the control program.

In terms of perceptions, fully 96 percent of the sample considered biting insects, such as black flies and mosquitoes, to be more of a problem than stinging insects. In addition, 71 percent stated that black flies were the most bothersome biting insect. Fifty-nine percent of respondents said that both swarming and biting of black flies cause discomfort, while only four percent stated that neither of these activities bothered them. With respect to seasonality, only 19 percent stated that late-season black flies were the most bothersome and 63 percent indicated that late-season and early-season varieties were equally bothersome. Eighty-eight percent of the respondents used some type of personal protection from black flies. Of those using protection, 57 percent were satisfied with their method. Finally, 22 percent of the households had family members who were allergic to black fly bites, and 26 percent of these households reported that a family member required medical attention due to an allergic reaction to black fly bites.

Comparing these qualitative responses to respondent's stated bids for the 90 percent level of control presents some mixed information. Obviously, black flies appear to be the most bothersome insect in the study area. Yet, a majority of respondents stated a maximum willingness to pay of zero dollars for control. Several conjectural insights may help to explain the inconsistency in these results. First, most respondents were concerned with both early- and late-season black flies. Perhaps value statements would have been higher for a program controlling all varieties of black flies. Also, most respondents use some type of personal protection from black flies and more than half of these individuals are satisfied with the level of protection achieved. Finally, only a small percentage of respondents experienced severe reactions to black fly bites. This evidence suggests that black flies may not be a serious problem to most residents of the study area. Demographic characteristics also may help explain the apparent inconsistency. The average respondent was 49 years of age, had lived in Maine for 44 years, had resided in the study area for 40 years, and had lived at their current residence for 18 years. Therefore, respondents have had time to adapt to black flies.

This conjectural evidence supports the conclusion that a black fly control program may not be important to residents of the study area. To investigate these conjectural relationships, a Tobit model was used to estimate the relationship between stated willingness to pay and selected variables. A Tobit model was used because ordinary least squares would yield biased and inconsistent parameter estimates when the dependent variable is censored (Maddala, 1983). The censoring here is the large number of stated zero values. The model is of the form:

$$Y_i^* = \beta' x_i + u_i \qquad i = 1, \ldots, n$$

and

$$Y_i^* = \begin{cases} Y_i & \text{if } Y_i > 0 \\ 0 & \text{otherwise.} \end{cases}$$

The dependent variable is the respondent's stated willingness to pay for the 90 percent level of control. The vector of explanatory variables (x_i), along with the vector of Tobit estimates of the parameters (β), are reported in Table 5. These coefficients were estimated from the data set after removing the observation identified as an outlier in the preceeding section. Note that four of the explanatory variables are binary and the direction of their effects is denoted in the first column of Table 5.

Before proceeding, it should be noted that the estimated coefficients in the second column of Table 5 measure the direction and magnitude of the effects of changes in the independent variables on the dependent variable (Y^*). The effect of any independent variable (x_j) on the latent dependent variable (Y) is derived as

$$\partial E(Y)/\partial x_j = [\Phi(\beta' x_i/\sigma)]\beta_j$$

where $\Phi(\bullet)$ is a standard normal distribution. The results of these calculations are presented in the third and fourth columns of Table 5.

The signs of the estimated coefficients are consistent with prior expectations. Stated willingness to pay increases if respondents find black flies to be more bothersome than other biting insects in Maine, or if the late-season varieties of black flies are bothersome to them relative to only the early season varieties, or if medical attention is required for black fly bites by a member of their household, or if they have a large household size, or if they have a high income. Stated willingness to pay declines if respondents currently use some type of self protection from black flies, or live away from the Penobscot River where the flies are primarily concentrated.

Two key variables are significantly different from zero: black flies are the most bothersome biting insect; and respondent uses some method of self protection from black flies. These are deemed to be "key variables" in the sense that seventy-one percent of the respondents stated that blackflies were the most bothersome biting insect and 88 percent stated that they used some method of self control. In contrast, medical attention required is also a significant variable, but less than 10 percent of those responding indicated that medical attention was required by someone in their household.

It is interesting to note that black flies being the most bothersome biting insect and respondents' use of self control have opposite effects on the dependent variable and the magnitudes of their effects are approximately the same (column 2 in Table 5). These counteracting effects help explain the large number of zero values for control reported by respondents. Remember, 57 percent of the respondents were satisfied with their method of control or protection from black flies. However, the magnitude of the effects of these two variables, given that a respondent bid a positive dollar amount, are quite different (column 4 in Table 5). The effect of black flies being the most bothersome biting insect is nearly twice as large as the effect of the respondent using self protection. Thus, across the entire sample, these two variables have countervailing effects that are approximately equal in magnitude. For the subset of respondents who bid a positive dollar amount, black flies being the most bothersome biting insect has a stronger effect that leads to higher statements of value when all other variables are held constant. Therefore, respondent perceptions of black flies appear to be consistent with their statements of value, and the large percentage of zero values appear reasonable.

Temporal Reliability

Temporal reliability focuses on whether respondents' statements of value are the same at two distinct periods in time (Kealy, Dovidio and Rockel, 1988; Loomis, 1989; and Mitchell and Carson, 1989). The issue of concern is whether statements of value for black fly control might be higher during the black fly season than they would be at some other point in time (Reiling *et al.*, 1989). To test this hypothesis the sample was randomly stratified into two groups of equal size. One-half of the respondents received the survey concurrent with the peak occurrence of late-season black flies in August and September, 1987. The other half of the sample received the surveys in late October and November, 1987, after the black flies had disappeared.

Estimated values for each group are reported in Table 6. The one outlier in the data occurred in the after-season sample and this observation has been removed from the statistics reported here. As one can visually observe, there is no statistically significant difference between the values for the in-season sample versus the after-season sample. Including the outlier observation in the after-season data did not change the results of these statistical tests. Therefore, the estimated contingent values are judged to be temporally reliable.

Table 6. Value Per Household Categorized by Timing of Survey Implementation

Level of Control		In-Season Sample	After-Season Sample
60 percent	— Mean ($)	6.56	7.37
	— s.e. ($)	1.14	1.16
	— n	199	183
75 percent	— Mean ($)	8.41	9.32
	— s.e. ($)	1.40	1.47
	— n	196	186
90 percent	— Mean ($)	13.75	14.04
	— s.e. ($)	2.02	1.91
	— n	198	195

Conclusions

The average value respondents place on late-season black fly control increases significantly as the level of control increases. It is interesting to note that the average value for 75 percent control is roughly $2 higher than the average value for the 60 percent control, while the average value for 90 percent control is about $5.00 more than the average value for 75 percent control. In addition, some respondents stating values of zero dollars for 60 and 75 percent control stated a positive value for 90 percent control. These results may reflect the opinion among respondents that the 60 and 75 percent control levels do not provide sufficient relief from black flies. If this is the case, the value respondents would attribute to control levels greater than 90 percent may be significantly higher than the $15 reported for the 90 percent level of control in Table 1.

The results also clearly indicate that the majority of the households placed a value of zero on all levels of blackfly control investigated. Since only one data outlier was identified, and since value statements were consistent with respondents reporting of their perceptions of black flies, and value estimates were temporally reliable, the zero values appear to be reasonable. Most respondents are unwilling to financially support black fly control, even when a 90 percent success rate is achieved. However, from a policy perspective, simply using estimated means and aggregating to a population value for a benefit-cost calculation would, in this case, obscure important information about the distribution of benefits.

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