

# AN EVALUATION OF A COMMUNITY BASED MOSQUITO ABATEMENT PROGRAM: RESIDENTS' SATISFACTION, ECONOMIC BENEFITS AND CORRELATES OF SUPPORT

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**ABSTRACT.** Using survey data from a random sample of residents, the efficacy of a comprehensive mosquito abatement program in Stuttgart, Arkansas, was evaluated. The findings indicate very high levels of satisfaction with abatement efforts among the residents. Additionally, estimates of benefit/cost ratios indicate benefits far outweigh costs. Regression analysis indicates that income and education are positively associated with level of support although there is a negative age effect.

## INTRODUCTION

The rice producing areas of eastern Arkansas are plagued annually by vast hordes of mosquitoes (Meisch and Coombes 1975). Stuttgart (population 11,000) is located 52 miles southeast of Little Rock near the center of the state's rice-growing area. Rice fields are directly adjacent to, and in some instances, located wholly within the city limits (Meisch and Inman 1988). Recognizing the mosquito problems associated with rice production, the Stuttgart City Council enacted Ordinance 216 prohibiting the cultivation of rice or maintenance of standing water within the city limits in 1919. A later ordinance allowed cultivation of rice within the city limits contingent upon cooperation with the local mosquito control agency. In 1951, a monthly charge of \$.10 per household and \$.15 for businesses was levied to fund mosquito control operations. By 1984, subsequent fee increases produced tax receipts of approximately \$70,000. In 1988, the average household paid an amount towards the mosquito control program that averaged \$3/month for 12 months. This revenue is generated through a flat fee of \$1.25/month attached to the garbage pickup portion of the household water, sewer, and garbage pickup bill and contributions from city sales tax receipts. Past mosquito abatement efforts were restricted to controlling adult mosquito populations. The adulticiding operations were often poorly timed with little analysis of the factors contributing to the mosquito problem and resulted in relatively poor control. A comprehensive mosquito abatement program was initiated in 1985. Employing a full-time manager and increasing the budget allocation to \$150,000 allowed the development of an integrated approach for controlling mosquitoes in Stuttgart. The implementation of public ed-

ucation programs, a surveillance network and a rice field larviciding program using the microbial agent *Bacillus thuringiensis* var. *israelensis* have served to differentiate the current abatement program from past control efforts.

## METHODS

Data for the analysis were collected from a random sample of the noninstitutionalized population of Stuttgart by a telephone survey conducted during the week of August 7, 1988. The final survey instrument consisted of a series of closed-end questions designed to: (1) assess citizens' opinions of the effectiveness of the program in combatting mosquitoes, (2) estimate the economic benefits of the program and (3) describe the general socioeconomic characteristics of the respondents.<sup>4</sup> Selection of the sample proceeded as follows. Telephone listings were first screened to eliminate all business, institutional (nursing homes, hospitals, etc.) and agency (city, county, state and Federal) numbers. Additionally, residents outside the Stuttgart city boundaries were excluded.

A random sample of 600 numbers was selected following the preliminary screening. These 600 numbers were then subjected to further screening to confirm eligibility. The second round of screening resulted in the exclusion of 52 numbers, leaving 548 eligible numbers. Reasons for exclusion in the secondary screening included telephone disconnects, recent institutionalization, and business numbers listed as residential. Among the 548 eligible numbers, there were 43 refusals and 23 households that were not contacted. The response to refusal rate was 91% and the overall response rate was 88%. These relatively high response rates can be attributed to several factors. First, prior to telephone contact, each sample member was sent a letter explaining the nature and importance of the research. Secondly, local media were contacted

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<sup>4</sup> An earlier draft of the survey instrument was pretested in the month prior to implementation.

prior to the survey, resulting in local newspaper and radio news announcements describing the survey effort and further sensitizing the population to the importance and legitimacy of the survey. Finally, extensive call back efforts were made, with up to 25 attempts (at varying times during the day, night and week) being attempted.

## RESULTS

The sociodemographic profile of the respondents is as follows: the mean age was 49.9 years and 63% of the respondents were female. Mean years of education was 12.4 (the median was 12.0), and the average length of residence in the community was 26.5 years. Mean household size was 2.6 persons, and 19% of the respondents were renters. These data compare favorably with secondary data (U.S. Department of Commerce 1982) describing the general population of the area, providing a high degree of confidence as to the representativeness of the sample.

Several questions were asked to determine the citizens' perceptions of the adequacy of the mosquito abatement program in Stuttgart. The most straightforward question was a multiple response category question: "Is Stuttgart's current mosquito problem worse, better, or about the same as before the control program started in 1985?" This question was asked only to those who lived in Stuttgart prior to the implementation of the current program. In this manner, we isolated those individuals who experienced the mosquito environment prior to the current abatement efforts and during the program.

The overwhelming majority of the respondents who had lived in Stuttgart prior to the institution of the program viewed the mosquito problem as being improved. Among the 425 respondents, 385 persons (91%) viewed the mosquito problem as better while only 40 (9%) assessed it as being unchanged or worse than prior to implementation of the abatement program. The findings also indicate that, of those who evaluated the conditions as better, 58% of the respondents indicated they spent more time in outdoor activities than before. This substantiates the efficacy of the abatement program in terms of improving the quality of life. Further, of those who were more active outdoors, 43.5% had spent more money for outdoor sports and outdoor entertainment equipment.

Another (more indirect) means of measuring the efficacy of the program was to measure the amount of mosquito control products (repellents, etc.) purchased by individuals during the mosquito season. Almost 350 respondents out of 473 (73.6%) had spent less than \$5 on these

products during the summer of the survey.<sup>5</sup> It should be noted that the majority of those who indicated they spent less than \$5 actually spent no money on control products. Specifically, of the 348 respondents who spent less than \$5, 285 (82%) had purchased no mosquito control products.

Although these findings provide convincing evidence of the residents' satisfaction with abatement efforts, the question as to how much the residents value the program in relation to its cost needs to be assessed. In order to do this, a contingent market valuation (CMV) technique was used. The CMV technique is based on the premise of a realistically designed, though hypothetical, market setting. An individual is asked to reveal his/her preference in the form of a bid (maximum amount willing to pay) contingent on the availability of the good in question. Several different approaches can be used to obtain willingness to pay data. The quantity of the good can be changed in increments and the individual asked to reveal his corresponding bid in an iterative manner (Ofiara and Allison 1986; see also Stoll et al. 1984; John et al. 1987a, 1987b). For a telephone survey, this iterative bid procedure has significant advantages.

The bidding technique employed in this research proceeds as follows. The question is asked "would you be willing to pay an additional 'X' dollars per month to maintain the mosquito control program at its present level?" The response to this question (yes or no) cues the questioner to ask the identical question, substituting a greater or lesser dollar amount. The iteration continues until a final, specific amount is determined. This final figure is the value that the respondent places on the program.<sup>6</sup> This bidding technique allows an estimation of the individual's willingness to pay (above current levels) in dollars for support of continuation of the program.

The mean bid and the upper and lower limits

<sup>5</sup> As a test of the internal consistency of the survey instrument the program evaluation variable and the repellent expenditure variable were cross tabulated. The  $\chi^2$  was 9.46 *d.f.* 1, indicating that responses were consistent across variables (those who viewed the program as not being effective spent more on mosquito control products).

<sup>6</sup> Recent research has revealed the potential of bias in the final bid depending on the starting point of the bidding (Boyle et al. 1985). Given that the bidding process was conducted verbally, this issue was particularly salient in the current evaluation. Therefore, in order to control for the potential of starting point bias, the bidding was conducted so as to begin at randomly assigned levels.

for the 68.3% confidence interval (that is, one standard deviation on either side of the mean) was an additional \$8.49 per month plus or minus \$2.88. These limits can be used to provide a meaningful range of the annual benefits of the program. The mean contingent value was \$11.49 (the mean bid value of \$8.49 was added to the average current contribution of \$3.00). The best estimate of benefits is derived by multiplying the mean per month bid by the number of households in Stuttgart. In October 1988 there were approximately 3,765 households and 395 businesses in Stuttgart that had water hookups according to records of the Stuttgart Water Department.<sup>7</sup> The dollar value of the monthly benefits for these households in the aggregate is \$43,260. On an annual basis, therefore, benefits are \$519,118. Employing the lower limit value of \$8.61 (\$8.49 - \$2.88 + \$3.00), the benefits would be \$388,999.80 on an annual basis. When the upper limit value of \$14.37 (\$8.49 + \$2.88 + \$3.00) is used, annual benefits would be \$649,236.60. The cost of the program in calendar year 1988 was \$151,678. Thus, using this cost figure, mean benefits were 3.4 times costs; benefits range from 2.6 times costs to 4.3 times costs.

While the above benefit/cost assessment of the abatement program provides insight into the overall economic value of the program, it gives little insight into the characteristics of the respondents. Specifically, willingness to pay may be contingent not only on the attributes of the program but also upon the characteristics of the individual. In order to provide insight into the impact of individual characteristics on the economic valuation of the program the following Ordinary Least Squares (OLS) regression model was estimated:

$$\text{VALUE} = \alpha + \beta_1 \text{PROBLEM} + \beta_2 \text{INC} + \beta_3 \text{ED} + \beta_4 \text{AGE} + \beta_5 \text{BPROG} + \beta_6 \text{BMethod} + \beta_7 \text{RELATIVE} + \beta_8 \text{INDUST} + \beta_9 \text{HOWN} + \beta_{10} \text{STPOINT} + \delta;$$

where

- VALUE is the bid level;
- PROBLEM is the response to the question of whether the mosquito problem has improved since implementation of the program;
- INC is household income;
- ED is the number of years of completed education;
- AGE is age of the respondent;

- BPROG is a dummy variable indicating whether the respondent had lived in Stuttgart prior to implementation of the current program (prior residence = 0);
- BMETHOD is the individual's opinion as to whether neighborhood programs versus a citywide or countywide program would be best in controlling mosquitoes (city, county = 0)
- RELATIVE is the individual's opinion as to whether Stuttgart's mosquito problem was better, worse, or about the same as in the surrounding area;
- INDUST is the individual's opinion as to whether the mosquito abatement program has made the city a more attractive place for industry to locate (no = 0);
- HOWN whether the respondent is a homeowner or renter (renter = 0);
- STPOINT is the starting value at which the bidding process began (see footnote 6).

In the case of a cross-sectional study, the  $\beta$  coefficients in the regression equation can be interpreted as the expected difference in the dependent variable (bid value) for one unit difference in the independent variable when other variables are held constant. The  $t$  statistic provides a means of assessing the probability that the coefficient, estimated from a sample, is different from zero in the population.

Table 1 presents the results of the estimated equation.

As expected, there is a positive and statistically significant relationship between the individual's evaluation of the program and the bid value; those who viewed the mosquito problem as being improved since the implementation of the mosquito abatement program had higher bids. The measure of whether the individual experienced the mosquito environment prior to implementation of the current program is also statistically significant and has the expected sign; those individuals who lived in Stuttgart prior to implementation were more likely to have higher bids. Opinion as to the best method for mosquito control (individual vs. group efforts) was not shown to have an impact on the final bid level. Similarly, neither opinion as to whether the current program had improved the probability of industry locating in the city, or whether the mosquito problem was worse outside town, appear to be related to the final bid amount.

<sup>7</sup> The benefits to the 395 businesses were not assessed in this study.

Table 1. Regression results of willingness to increase current contributions to the mosquito abatement program and individual characteristics.

Variable	Regression coefficient*	t-value	Probability of t
Intercept	-3.66 (0)	1.24	0.216
PROBLEM	2.03 (0.16)	2.22	0.027
INC	0.07E3 (0.22)	3.86	0.001
ED	0.23 (0.12)	2.28	0.023
AGE	-0.04 (-0.12)	2.38	0.017
BPROG	-3.01 (-0.16)	2.28	0.023
BMETHOD	4.04 (0.09)	1.80	0.072
RELATIVE	0.92 (0.07)	1.43	0.154
INDUSTRY	-0.17 (-0.06)	1.36	0.176
HOWN	-0.26 (-0.01)	0.34	0.731
ST POINT	0.37 (0.14)	3.04	0.002
R <sup>2</sup>	0.17		
Adjusted R <sup>2</sup>	0.15		

\* Original metric coefficient on top, standardized estimate in parentheses.

The regression results indicate a net positive relationship between socioeconomic status and higher bid values. Specifically, coefficients for income and education are positive and statistically significant. Income is the strongest (in terms of relative magnitude of the coefficients) predictor of willingness to pay. In contrast, there is a significant negative age effect. This is not unexpected and indicative of the general trend toward fiscal conservatism with increasing age. It is also notable that there is no statistically significant relationship between home ownership and the willingness to increase the amount of the contribution to the program.

## CONCLUSIONS

The results of this study indicate that the overall public assessment of the mosquito abatement program implemented in 1985 in Stuttgart, Arkansas, is highly positive. Findings from the random sample of households indicate that the vast majority of the respondents view the current mosquito problem as being improved over what it was prior to implementation of the program.

The current findings imply that the community based, integrated abatement program that includes public awareness efforts, ongoing surveillance, extended larviciding and adulticiding

is clearly more effective than earlier efforts (that were characterized by less systematic adulticiding).

The findings of community satisfaction with the integrated efforts are bolstered by the benefit/cost estimates. Employing the most conservative estimates of economic benefits indicates that the costs, although not trivial, are substantially outweighed by the corresponding benefits.

In terms of valuing the program, closer examination of the characteristics of individuals has provided insight into the support base within the community. Specifically, the analysis indicates that income and education are strongly associated with willingness to increase contributions (to maintain the current level of abatement efforts). Conversely, age has a relatively strong negative effect. These results have direct implication for communities considering implementation or modification of abatement programs.

Stuttgart is not the only city in the region with a mosquito abatement program. Several smaller cities in the lower Mississippi Delta also have similar programs. Further research could analyze the mosquito abatement programs in these small towns and then compare the results with those of Stuttgart. A particularly interesting question is whether diseconomies associated with smaller cities cause the benefit/cost ratio for abatement to be below 1.0.

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