9-1988

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ISSN 0734-9548

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Bulletin 822 September 1988

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ACKNOWLEDGEMENTS

This research was funded in part by a contract with the Maine Department of Environmental Protection. We express our appreciation to David Courtemanch, who served as project officer, assisted in the design of the research and reviewed an earlier draft of the report.

We also express our appreciation to George Criner and Forest French. They reviewed earlier drafts and made several suggestions that improved the quality of the publication.

Finally, we appreciate the assistance of the people in the study area who took the time to complete the questionnaire and return it to the University. This publication would not have been possible without the information they provided.

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I. INTRODUCTION

Background

Black flies are a major pest in some areas of the U.S., Canada and other countries around the world. Although black flies do not carry diseases in the U.S., their bites are painful to humans and can cause allergic reactions. The swarming action of black flies is also a nuisance. In severe situations, black flies can significantly limit outdoor activities. Livestock can also be affected; cattle may stop feeding, lose weight, or produce less milk because of black flies.

Black flies inhabit rivers and streams during the larval stage. Consequently, efforts to control black fly populations are usually directed at the larvae in streams. Control programs, however, are controversial because of the need to introduce control agents into streams used for drinking water, recreation and other uses (Gibbs, *et al.*, 1986). Concerns also arise with respect to the effect of the control agent on non-target aquatic life, especially fish.

Some states, including New Hampshire, New York, and Pennsylvania, as well as some Canadian provinces, have initiated black fly control programs. One of the largest programs in the U.S. was conducted in Pennsylvania in 1985 and 1986 (PA Black Fly Suppression Effort, 1986). About 290 stream miles of the Susquenhanna River and 245 miles of the Allegheny River were treated with 93,000 gallons of the biological insecticide *Bacillus thuringiensis* var. *israeliensis*, or *Bti*. The insecticide was sprayed into the rivers from helicopters at a height of ten to fifteen feet. Overall, the Pennsylvania control program cost $2.9 million and resulted in about a ninety percent reduction in the black fly population. Other black fly control programs have been smaller in terms of the area covered and many have been experimental in nature.

There have been some small, experimental applications of *Bti*, in the Carrabassett River and a tributary stream in the Sugarloaf area of Maine (Gibbs, *et al.*, 1986). In addition, the Maine Legislature enacted a resolution in 1985 to appropriate $30,000 for the Maine Department of Environmental Protection to supervise research on black fly control. Part of the $30,000 was to be used to quantify the adverse economic impact caused by black flies, and to estimate "economic benefits that might accrue from their control" (Maine State Legislature, 1985).

Economic feasibility studies are conducted to compare the costs and the benefits associated with pest control programs. If the economic benefits of the control program are greater than the costs of achieving the benefits, the

control program is justified from an economic perspective. However, no studies have been conducted, in Maine or elsewhere, to determine the economic feasibility of a black fly control program. The absence of such studies is due, in part, to the difficulty of measuring the economic benefits associated with control efforts. This difficulty stems from the fact that the benefits of any pest control program are nonmarket in nature. That is, markets do not exist for individuals to purchase desired levels of pest control. Consequently, nonmarket techniques must be used to measure the value people place on pest control programs. Although these nonmarket techniques have not been applied to black fly control programs, they have been used to determine the value of other types of nonmarket goods, including the value people place on mosquito control programs.

Purpose of Report

The Maine Department of Environmental Protection (DEP) contracted with the Department of Agricultural and Resource Economics at the University of Maine to study the economic benefits of black fly control. The DEP requested that the study focus on the benefits of late-season black fly control. This decision was based on the belief that any control program for black flies would be initially directed toward the late-season varieties since they primarily exist along the Penobscot River between the towns of Millinocket and Howland.

Although many species of black flies exist in Maine (Bauer and Granett, 1979), they can generally be divided into two categories: early-season and late-season varieties. Early-season varieties appear in early spring and disappear in late June or early July, while late-season varieties emerge in July and disappear in late September or October. Early-season black flies occur throughout the state, thus making any type of control problematic. Late-season varieties, in contrast, are particularly amenable to control due to their geographical specificity.

The purpose of this report is to present the results of a study to measure the economic benefits of late-season black fly control. The study objectives were to:

1. Determine the attitudes of residents toward early- and late-season black flies and other pests in the study area;
2. Measure the economic benefits of late-season black fly control that would accrue to residents of the study area; and,
3. Determine the factors that influence the magnitude of the economic benefits of late-season black fly control.

These objectives were addressed using data obtained through a mail survey from residents of the study area.

It should be noted that the costs associated with black fly control were not measured in this study. The study only focused on the benefits of control. The results of the present study can be used to determine whether the benefits are greater than the costs when specific programs are proposed and their costs are known.

Organization of Report

The economic theoretical aspects of measuring the benefits of black fly control are discussed in the next section. The unique characteristics of a pest control program, and the techniques that can be used to measure the benefits of late-season black fly control, are discussed. The study area and data collection procedures are described in Section III, and the results of the study are reported in Section IV. Implications of the results are summarized in Section V.

II. THEORETICAL FRAMEWORK OF THE STUDY

Measurement of the benefits associated with pest control is a complex issue because such programs are a classic example of a public good. Many consumer goods are bought and sold in markets, where the conditions under which the transaction takes place and the prices at which the goods are exchanged can be observed. These observations provide information about the value people place on the goods exchanged. Unfortunately, markets do not exist for public goods, including pest control; thus, market data are not available for discerning the value, or the benefits, associated with control. Markets for pest control do not exist either because one person's efforts will also yield uncompensated control for others, or one individual's control efforts are not sufficient to significantly reduce the nuisance level of the pest. Since markets do not exist for public goods, the benefits associated with pest control must be inferred using nonmarket data.

A public good is unique in that all consumers can consume the good simultaneously once it is provided. Furthermore, the consumption of the good by one person does not reduce the quantity available for others to consume. The public-good nature of black fly control is easily understood when one recognizes that all people who reside in the control area benefit simultaneously from the reduction in the black fly population. All residents enjoy the relief associated with fewer bites and fewer swarming flies, and one person's enjoyment of this relief does not reduce the relief received by others in the control area. Since all people benefit simultaneously, black fly control is usually provided collectively through government action so the power of taxation can be used to raise the revenue required to pay for its provision. However, the need still exists to evaluate the benefits of black fly control to determine whether the program is economically feasible.

Possible Measurement Techniques

Given the public-good nature of black fly control, it is necessary to resort to either a market-related or a nonmarket method to estimate the benefits associated with control. Market-related approaches are desirable from the perspective that control benefits are derived from transactions or activities directed toward minimizing the effects of black fly infestations. However, the actual derivation of benefits from these transactions can be quite complicated and problematic. Nonmarket procedures for measuring benefits, in contrast, are more straight forward, but do not give the assurance that they are derived from any type of market transaction. Three market-related procedures and one nonmarket method are discussed below as potential techniques for measuring the benefits of black fly control.

The first method, referred to as the "opportunity cost" approach, uses estimates of what people are currently paying for personal control of black flies and what they are paying for the treatment of health problems related to black fly bites as an estimate of the benefits of control. A sample of people from the proposed control area is surveyed to elicit their annual expenditures for controlling black flies and for treating black fly bites. Responses are averaged, and the mean expenditure per year is interpreted as the minimum per-person benefit of a control program that eliminates black flies. A control program is feasible if the average annual expenditure exceeds the annual cost per person of achieving 100 percent control. Given that benefit estimates represent a minimum threshold, control strategies with costs exceeding the benefits should not be automatically dismissed.

The opportunity cost approach has a number of significant limitations. No method of control is 100 percent effective, and individuals may continue to make some expenditures for personal control and health problems related to black fly bites. If this occurs, the opportunity cost approach would yield an overestimate of benefits and could lead to the implementation of a strategy that is not economically feasible.

Other problems could result in an understatement of benefits. If a person makes a substantial personal investment in black fly control, neighbors may also benefit. In turn, neighbors who enjoy the spillover effect may under-invest in black fly control. That is, a higher level of control might be attained if the neighbors cooperated. Conversely, black flies can travel up to 20 miles and individual control may be impossible. Each of these problems could lead to an understatement of benefits and an economically feasible control program, where benefits exceed costs, may not be implemented.

In practice, it is extremely difficult to measure existing control and health expenditures, and it is even more difficult to assess whether benefit estimates are overstated or understated. For this reason the opportunity cost approach was not employed in the current study.

A second market-related method for assessing the benefits of control is commonly referred to as the "hedonic" approach. (See Anderson and Bishop (1986) for a discussion of this approach.) This procedure involves an examination of property values in two communities that are similar in nearly all respects except for the degree of black fly infestation. All other things equal, the community with the lower level of infestation would presumably have slightly higher property values. The aggregate benefits of control could be inferred by comparing differences in property values.

The hedonic approach, however, has problems that are more significant than those related to the opportunity cost approach. No two towns are nearly identical, and it is extremely difficult to identify and quantify all of the fac-

tors that cause differences in property values. More importantly, any effects of black fly infestations on property values may be so small, relative to other factors, that it may be impossible to statistically identify these effects.

Even when successful, the hedonic approach can only provide a benefit estimate for the difference in infestation levels between the communities. This may or may not correspond to the level of reduction obtained from a control program. Furthermore, the hedonic approach is most applicable for comparing similar suburbs in a large metropolitan area where most of the properties are residential. It is less applicable for small towns with differing residential and business districts. Finally, once an estimate of benefits is obtained, questions remain as to what time frame of control costs should be used for comparison. For all of these reasons, the hedonic approach was not used.

The third market-related approach, the travel-cost method, is only appropriate for measuring the recreation benefits associated with black fly control. (See Anderson and Bishop (1986) for a discussion of this approach.) The conceptual basis for this approach is similar to that of the hedonic approach. Benefits are measured by comparing the travel costs associated with two recreation sites that differ only in the degree of black fly infestation. Assuming that people must travel farther to find a site with fewer black flies, the difference in travel costs between the two sites is used to estimate the benefits of control.

The travel-cost approach shares some of the same problems encountered in the hedonic approach. No two recreation sites are identical in all respects except for the degree of black fly infestation, and it is difficult to account for all of the other differences between sites. In addition, benefit estimates can only be developed for observed differences in infestation, which, once again, may not correspond to the level of control being evaluated.

The travel-cost approach also encounters some unique problems. It is only applicable for measuring recreation benefits away from home. It can not be used to estimate the benefit of control around one's home, since there are no travel costs for inferring benefits. Also, this approach can not be used to measure the benefits of control for individuals who work out-of-doors. Consequently, the travel-cost method is inappropriate for the current study.

The fourth approach, contingent valuation, involves selecting a sample of individuals from the proposed control area and asking them to state the maximum dollar amount they would pay for a specific level of control. (See Anderson and Bishop (1986) for a discussion of this approach.) Contingent valuation is a nonmarket technique in that all transactions are hypothetical and no money actually changes hands.

The obvious criticism of this approach was succinctly expressed by an

economist who stated: "ask a hypothetical question and you will get a hypothetical answer" (Scott, 1965, p.37). Nearly two decades of research have been dedicated to refining and validating contingent valuation since Scott made this cynical comment. In fact, the conclusion of a "state of the arts assessment" was that:

> the final assessment is generally positive. We find impressive the accuracy of (contingent valuation) measures inferred by the available evidence at this stage of the method's development. We find encouragement in the . . . results . . . which suggest that breaking the 'hypothetical barrier' in (contingent valuation) may not be as hopeless as we and others earlier believed" (Cummings, Brookshire and Schulze, 1986, p. 234).

Recent research has shown that comparisons of contingent values with estimates derived using actual cash transactions yield comparable benefit estimates (Dickie, Fisher and Gerking, 1987; Heberlein and Bishop, 1986; and Welsh 1986).

With respect to the current study, contingent valuation allows the researcher to avoid many of the problems encountered with the opportunity cost, hedonic and travel cost methods. Contingent valuation questions can be designed to value the specific level of proposed control. Statements of value can be elicited for a season, year or any time frame that is consistent with the cost structure of the proposed control method. Furthermore, the aggregation problem is simplified. If a representative sample is drawn from the potential beneficiaries, the average value obtained from the sample can be multiplied by the number of people who will benefit from control to obtain an aggregate measure of benefits. Contingent valuation is also capable of measuring the total benefits of control (at home, at work, recreation and health). For these reasons, contingent valuation was chosen as the approach for estimating the benefits of black fly control in the current study.

A review of the literature indicates that no economic studies have been conducted to evaluate the benefits of a program to control black flies. Two recent studies, however, estimated the benefits of public mosquito control programs using contingent valuation (John, Stoll and Olson 1987; and Ofiara and Allison 1986). Measuring the benefits of mosquito abatement encompasses the same nonmarket and public good problems that arise for a black fly control program. These studies, therefore, establish a precedent for using contingent valuation in the present study.

Contingent Valuation Explained

Contingent valuation derives its name from the procedure used to ask individuals to state the maximum dollar amount they would pay for a stated program. That is, study participants are asked to state a dollar amount, contingent upon the existence of a market or other means through which they

could pay for the program. As stated above, statements of value are elicited in a survey setting and no money actually changes hands. Given the hypothetical nature of contingent valuation, the survey instrument must be carefully designed to address six issues: (1) Whose values will be estimated? (2) How will the item to be valued be defined? (3) What payment method will be used? (4) How will the contingent valuation question be asked? (5) How will the data (responses to the contingent valuation question) be analyzed? and (6) What supplemental information will be required? Each issue is discussed below in reference to the current study.

Whose Values will be Estimated?

The proposed control effort is directed at late-season black flies along the Penobscot River from Millinocket to Howland. The individuals that would benefit from control are primarily residents of communities located along this section of the river. Therefore, a random sample of heads of households residing in the communities along the river, between Millinocket and Howland, was selected for use in the study. The sample is discussed in detail in the next section of the report.

Some individuals who do not reside in the sample area may still work, shop and recreate in the control zone. However, omission of these individuals should not cause a substantial problem because most of the area outside of the communities sampled is unorganized territory with a small population, and most of the recreation along this stretch of the Penobscot River is attributed to local residents.

Description of Control Strategy

Black fly control (the item being valued) was described to respondents using a written statement in the survey. This statement indicated that control would only affect the number of *late-season* black flies, and that the biological agent *Bti* would be used. The statement also indicated that other control programs using *Bti* have been conducted elsewhere, and that no undesirable environmental impacts were anticipated. The exact wording of this explanation is presented in Part III of the questionnaire contained in the Appendix. Respondents also were informed of the control area: all towns on either side of the Penobscot River between Millinocket and Howland.

Payment Vehicle

Payments for control would be made by creating a special district to which annual payments would be made. An obvious alternative to the special district would be a property tax surcharge on residential properties. However, this fee structure was not used in the survey since it would not directly affect renters. The objective of the questioning format is to obtain an estimate

of how much all households in the control zone would benefit, regardless of whether they owned or rented a home. More importantly, some people find the concept and practice of taxation to be offensive. The payment vehicle should not be offensive since the goal is to have individuals react to the proposed control and not to the method of payment; the payment vehicle is merely a method of facilitating statements of value. In short, a payment vehicle should balance two potentially competitive objectives: realism and neutrality. The special control district represented a good compromise. For a discussion of the importance of selecting an appropriate payment vehicle see Greenley, Walsh and Young (1985) and Mitchell and Carson (1985). See Part III of the questionnaire in the Appendix for the complete description of the control area and the method of payment.

Question Format

The contingent valuation question was asked using an "open-ended" format. (For a discussion of contingent valuation questions see Boyle and Bishop, 1988; Sellar, Stoll and Chavas, 1985; and Smith, Desvousges and Fisher, 1986.) That is, respondents were simply asked to state the highest annual dollar amount they would pay. Since the actual level of control that could be attained by the program was unknown at the time the survey was conducted, respondents were asked to value three levels of control: 60, 75 and 90 percent reductions in the population of late-season black flies. The three valuation questions were placed sequentially in the survey. Questions 17, 18, and 19 in the questionnaire illustrate the exact wording used to elicit values.

Data Analysis and Supplemental Information

Analysis of responses to the contingent valuation questions and the need for supplemental information are interrelated issues in that the latter is required to perform the former. Since respondents are asked to report the maximum amount they would pay for a hypothetical program, supplemental information about the respondents' motivation for choosing that amount is needed. This information is used to determine whether the response to the contingent valuation question is an accurate indication of the value the person places on control, or whether the response is inaccurate for some reason.

Several factors can result in inaccurate responses to the contingent valuation question. For example, some respondents may not approve of the establishment of a special control district to implement the control program. Consequently, they may respond that they do not place any value on control, not because they place a zero value on black fly control, but because they oppose the special district. In this case, the zero values are not accu-

rate measures of the maximum annual value they place on control. Instead, their responses are deemed to be a protest of the special district, and are eliminated from the data set prior to analysis. Strategic behavior on the part of a respondent can also occur. Strategic behavior is characterized by respondents giving very high or very low values in an attempt to influence the outcome of the study. Strategic responses are also removed from the data set before analysis.

To identify these types of inaccurate responses, respondents are asked to indicate the reason they gave the answer provided to the valuation question. This provides supplemental information from which the researcher can determine whether the response given is an accurate representation of the value the respondent places on control, or whether it is a protest or strategic response. Questions 20 and 21 in the questionnaire provided the supplemental information used to determine the validity of responses to the contingent valuation question.

After removing the invalid responses, sample averages of the contingent valuation responses are calculated for each of the three levels of control as estimates of the average value households placed on the specified level of control. Statistical confidence intervals for the averages are also calculated.

The sample average and corresponding confidence interval represent one piece of information for policy makers evaluating a proposed control program. Respondents' answers to the valuation questions also can be used as dependent variables in regression equations to determine what socioeconomic and environmental variables affect statements of value. For example, does income have a significant and positive effect on value? A regression equation of this type was estimated for the 90 percent control level. It is discussed in Section IV of the report.

Finally, the average values obtained from the sample must be aggregated to a population total to be compared with aggregate estimates of control costs. This is done by multiplying the number of households in the control zone by the mean values for the 60, 75 and 90 percent control levels. This procedure, of course, assumes that the sample is representative of the population residing in the control area.

This discussion of the issues associated with performing a contingent valuation study provides an overview of the procedures used in this study. The remainder of the report explains the procedures in more detail and presents the results obtained in the study.

III. SURVEY PROCEDURES

Late-season black flies are most abundant along the Penobscot River between Millinocket and Howland, and an ideal sample would include all residents of the towns and unorganized areas adjacent to, or near, the Penobscot River between these two towns. However, the available sample was selected on the basis of the zip codes served by the post offices in communities adjacent to the river between Millinocket and Howland. The actual study area, therefore, encompasses the organized towns and unorganized areas that are served by these post offices. Organized towns in the study area include Chester, East Millinocket, Edinburg, Enfield, Howland, Lincoln, Lowell, Mattawamkeag, Medway, Millinocket, Sebois, Winn and Woodville. Unorganized areas within the study area include Grindstone, Mattamiscontis and Norcross.

Millinocket, with a population of 7,311, is the largest town in the study area, followed by Lincoln (4,955) and East Millinocket (2,214). There was a total of 7,756 households in the organized towns in the study area in 1986, with an average of 2.82 persons per household. The organized towns in the study area had a total population of 21,899 in 1986 (Maine Department of Human Services, 1987).

Population data are not available for the individual unorganized areas in the study area. However, the Maine Department of Human Services (1987) estimated that the population of all unorganized areas in northern Penobscot County was 227 in 1986. Using the average of 2.82 persons per household for the thirteen towns in the study area, approximately 80 households reside in the unorganized areas within the study area. Therefore, it is estimated that a total of 7,836 (7,756 + 80) households lived in the study area in 1986.

Per-capita income levels of residents in the organized towns in 1983, the most recent year for which data are available, averaged about $7,900, but varied significantly among towns (Bureau of the Census, 1986). Per- capita incomes ranged from $5,222 in Chester to $9,246 in Millinocket. Millinocket and East Millinocket ($9,204) are the only towns in the study area with per-capita incomes over $8,000.

According to the Maine Department of Labor (1987), there were 8,621 people in the labor force in the organized towns in 1986. The overall unemployment rate for these communities was 7.4 percent. Unemployment rates in the individual towns ranged from about 2.1 percent in Woodville to 16.6 percent in Mattawamkeag. Medway had the second-highest unemployment rate of 10.0 percent.

Questionnaire Design

A mail questionnaire was designed to obtain the information needed for the study. The questionnaire, which is contained in the Appendix, has four sections. The first section contains questions about residents' perceptions of black flies in relation to other insect pests, when and how black flies bother them, and the methods, if any, used to control or protect members of their household from black flies.

The second section elicited information from those households in which at least one member suffered allergic reactions from black fly bites. The requested information included the number of persons in the household who suffer allergic reactions, the symptoms and severity of the reactions, whether medical treatment is normally required, and, if so, the approximate annual amount of medical expenses incurred for the treatment of the allergic reactions.

The third section was designed to determine the monetary value residents place on the control of late-season black flies, using the contingent valuation method. Information about control was provided and respondents were asked to indicate the maximum annual amount their household would pay to achieve 60, 75 and 90 percent reductions in the late-season black fly population. Respondents were also asked to indicate why they chose those dollar amounts as answers to the valuation questions.

The final section of the questionnaire asked respondents to provide selected socioeconomic characteristics of themselves and their household. These data were collected to determine if they were related to the maximum dollar value the household placed on late-season black fly control.

Once designed, the questionnaire was pretested by mailing it to 50 households, chosen at random from the telephone directory, residing in the study area. Pretest respondents were asked to complete the questionnaire and to make any comments about the questionnaire that would improve its clarity, organization and completeness. Some participants (both respondents and nonrespondents) were telephoned by the researchers to clarify problems identified in the pretest survey. The questionnaire was then modified based on the comments received.

Sampling Procedures

Based on the population of the area, the response rate from the pretest survey and the budget available for the study, a sample size of 700 households was chosen for the study. The pretest response rate suggested that a sample size of 700 would result in a minimum of 300 responses. A randomly selected sample of households from within the study area was purchased

from Survey Sampling Incorporated, of Fairfield, Connecticut. Six households in the sample were removed, since they had participated in the pretest survey. Thus, a total of 694 households received questionnaires.

The sample was divided into two equal groups of 347 households. The first group was surveyed during the late-season black fly period (August and September of 1987) and the second group was surveyed after the late-season black fly period (late October and November). This stratification of the sample was used to determine whether the time in which the households were surveyed influenced responses to the survey questions. In particular, the researchers wanted to determine if residents would state a higher monetary value for control when surveyed during the time period in which late-season black flies are most prevalent. The questionnaires for the two groups differed in only one respect. The first group was asked to report information on allergic reactions and medical expenses for treatment during 1986. The second group, which was surveyed after the 1987 season, was asked to report allergy information and medical treatment expenses for 1987.

Data Collection Procedures

Prior to mailing the questionnaire, each household in the sample was sent a letter informing them of their selection. The letter also explained the reasons for the study, and requested their cooperation by watching for the questionnaire and completing it when it arrived. The first copy of the questionnaire was mailed about three days after the initial letter. One week later, a postcard reminder was sent. A second copy of the questionnaire was sent about two weeks later to those households that did not return the first questionnaire. Finally, after two more weeks, a third copy of the questionnaire was sent to the households that had not returned either of the first two copies. The third copy was sent by certified mail so that undeliverable surveys would be returned to the University, thus indicating how many of the questionnaires could not be delivered. Some of the non-responding households were also contacted by telephone to encourage them to complete and return the questionnaire. This approach was used for both groups of 347 households.

IV. RESULTS

A total of 224 completed questionnaires was returned by the first group of households surveyed during the late-season black fly period. Forty-five questionnaires, or 13 percent, were not deliverable. Hence, the response rate for this group was 74.2 percent (224 of the 302 deliverable questionnaires).

The response rate for the second group of households (those surveyed after the season) was slightly lower, 69.0 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 a response rate of 71.6 percent.

In all surveys based on a sample, it is important to determine whether those responding to the survey are representative of the population from which the sample was drawn. This is especially important if, as in this study, the survey responses are to be used to draw inferences about the population as a whole. To make this comparison, available secondary data on household size, household income and the unemployment rate for the geographical area approximating the study area were compared with the survey data to determine whether statistically significant differences existed.

The results of the comparison are somewhat mixed, but suggest that the respondents are generally representative of the population in the study area. For example, the average household size calculated for the sample households (2.85 persons) was not statistically different than the average household size reported for all households in the study area (2.82 persons).

In contrast, the 1986 average income level of sample respondents ($28,516) was statistically higher than the estimated household income level of all households in the study area ($24,713). However, it should be noted that the 1986 average household income for all households in the study area had to be estimated from 1979 household incomes reported by the Bureau of the Census (1983). This was done by increasing the 1979 average income by 46.7 percent, which represents the rate of inflation that occurred in the U.S. economy between 1979 and 1986. Therefore, the estimated household income of $24,713 may not accurately reflect the actual 1986 average income level of households in the study area.

Finally, the unemployment rate among the heads of households in the sample was 5.1 percent, compared to an overall unemployment rate for the study area of 7.2 percent in 1986. Again, however, other factors may contribute to the observed difference. First, the two unemployment rates represent two different time periods. The sample data are based on employment status during the third and fourth quarters of 1987, while the overall

rate for the study area is an average for 1986. In addition, the unemployment rate obtained from the sample data pertains only to the employment status of the head of the household, while the overall rate reported for the study area pertains to the entire labor force that resides in the study area. These differences make it difficult to assess the actual magnitude of the difference in unemployment rates.

Even though the above comparisons reveal some differences between the sample respondents and the population of the study area, the differences are not large enough to conclude that the sample is not representative of the general population. Consequently, the results presented below from the sample data are considered to be a good approximation of the attitudes and opinions of the population residing in the study area.

Before presenting the overall results, it is important to recall that the survey data were collected in two stages. One-half of the study participants was surveyed in August and September and the other half was surveyed in October and November. A comparison of the responses from the two groups indicates that responses to the core questions of the survey, including attitudes toward black flies and other pests, the value placed on control, and household characteristics were not statistically different. Therefore, the results reported below are based on the data obtained from both groups and are not reported separately for each group.

Attitudes Toward Black Flies and Related Issues

Respondents indicated, overwhelmingly, that, among all flying insects, those that bite (such as black flies, mosquitoes, and deer flies) are a much greater problem than those that sting (such as bees, hornets and wasps). Over 95 percent of the respondents considered biting insects to be more bothersome than stinging varieties.

Among the biting insects, almost 71 percent of the respondents identified black flies as the most bothersome (see Table 1). In comparison, mosquitoes and no-see-um's, each, were identified by about 13 percent of respondents, and less than three percent of the respondents considered deer flies to be the most bothersome. These responses clearly indicate that residents consider black flies to be the most bothersome flying insect.

When asked whether early-season, or late-season varieties of black flies were the most bothersome, the majority of respondents (63 percent) replied that both varieties were bothersome (Table 2). Among those that identified only one variety, slightly more respondents cited the late-season varieties as being more bothersome than the early-season varieties. Only about three percent indicated that neither variety was bothersome.

Table 1. Resident Opinions about the Types of Biting Insects that are Most Bothersome.

	Respondents Ranking Insect as Most Bothersome	
Type of Insect	Number	Percent
Black Flies	292	70.9
Mosquitoes	56	13.6
No-See-um's	53	12.9
Deer Flies	10	2.4
Other	1	0.2
Total	412	100.0

Table 2. Resident Attitudes about Early- and Late-Season Black Flies.

	Respondents Ranking Variety as Most Bothersome	
Variety of Black Fly	Number	Percent
Both Varieties	272	63.1
Late Season	83	19.3
Early Season	64	14.8
Neither Variety	12	2.8
Total	431	100.0

The majority of respondents (59 percent) indicated that swarming and biting of black flies were both major sources of discomfort (Table 3). Among the respondents that chose either swarming or biting, only slightly more chose biting (20.3 percent) over swarming (17 percent) as the greatest cause of discomfort.

Table 3. Sources of Discomfort and Annoyance Associated with Black Flies.

	Respondents Ranking Behavior as Most Discomforting	
Type of Behavior	Number	Percent
Both Swarming and Biting	253	59.0
Biting	87	20.3
Swarming	73	17.0
Neither Swarming nor Biting	16	3.7
Total	429	100.0

Itching is the most common characteristic of black fly bites, followed by a red dot in the center of the bite, and swelling (Table 4). Bleeding was reported only by a relatively small proportion of respondents. However, 32 percent indicated that the bites exhibited all these characteristics.

Table 4. Characteristics of Black Fly Bites Reported by Residents.

Characteristic	Respondents Reporting the Characteristic	
	Number	Percent
Itching	258	59.9
Red Dot in Center of Bite	145	33.6
Swelling	140	32.5
Bleeding	55	12.8
All Characteristics Listed Above	136	31.6
Other	12	2.8
Total	431	*

* Percentages sum to more than 100 percent because of multiple responses.

Over 88 percent of the households took some type of action to avoid, or to provide protection from, black flies. Several types of actions were taken, the most common being the use of a repellant by about 82 percent of the respondents who took some kind of action (Table 5). The second-most frequent action was to remain indoors as much as possible during the black fly season (33 percent), followed by the use of a bug "zapper" in the early evening (18 percent) and wearing light-colored clothing (14 percent). Fewer than five percent of the residents reported taking the extreme action of leaving the area during all or part of the black fly season.

Table 5. Actions Taken by Residents to Avoid, or Provide Protection from, Black Flies.

Action Taken	Respondents Taking the Action	
	Number	Percent
Use Black Fly Repellant	308	81.5
Remain Indoors as Much as Possible	123	32.5
Use "Bug Zapper"	67	17.7
Wear Light-Colored Clothing	54	14.3
Leave Area During All/ Part of Black Fly Season	18	4.8
Other Actions	48	12.7
Total	378	*

* Percentages sum to more than 100 percent due to multiple responses.

When asked how satisfied they were with the level of protection provided by their actions to avoid, or to provide protection from, black flies, only eight percent of the respondents were "very satisfied" and about 50 percent were "somewhat satisfied". On the other hand, 18 percent were "somewhat dissatisfied," and 25 percent were "very dissatisfied" with the protection provided by the actions taken.

Ninety (22 percent) of the households indicated that at least one member suffered allergic reactions when bitten by black flies. Among these households, 70 percent had only one member that suffered allergic reactions, and only five households indicated that more than two members suffered allergic reactions when bitten. Overall, 118 people, or 9.7 percent of the people in all households surveyed, suffered allergic reactions.

Among the households stating that at least one member experienced allergic reactions, 26 percent (23 households) indicated that the allergic reactions were severe enough to require medical attention. Twelve of these households made a total of 30 medical visits during the year for which information was requested. Thirteen households indicated that one or more members missed at least one day of work because of black fly bites, or the need to care for a person suffering from black fly bites. Five of the thirteen households reported losing more than ten days of work due to black fly bites. Although severe allergic reactions requiring medical attention can be quite serious, this problem is limited to a relatively small portion of the population.

About 20 percent of all households spent money for medical services and/or prescription and non-prescription drugs (calamine lotion, anti-itch creams, etc.) during the year for which information was obtained. A total of $2,400 was expended, or an average of $6.00 per year per household.

Economic Value of Late-Season Black Fly Control

As explained in detail above, respondents were given specific information about black fly control before being asked to state the value they placed on it. Maximum values were elicited for control levels of 60, 75 and 90 percent reductions in the population of black flies. These three levels were evaluated for several reasons. First, previous control programs have experienced varying levels of success. For example, the Pennsylvania program described in Section I achieved reductions of black flies ranging from 43 to 99 percent, depending on the time and location of control. In most instances, the level of control ranged from 60 to 98 percent reductions.

Second, since a control program has not been implemented in the study area, the exact level of control that can be achieved is unknown. Variables such as water volume, water temperature and flow characteristics of the river

at the time of control can influence control. Finally, the level of control actually experienced by a household may vary within the study area, due to factors such as the distance from residences to the river, and the proximity of residences to other streams that may harbor late-season black flies. Therefore, information about the value residents place on different levels of control may result in improved estimates of the economic benefits when more information is available about the level of control that can be achieved, or to evaluate the economic feasibility of a variety of control levels.

As noted in Section II, some responses to the contingent valuation question should be removed from the data set prior to analysis. In this study, 73 responses were eliminated. These were removed because respondents either opposed the special government district, did not believe that it was possible to control black flies, behaved strategically when answering the contingent valuation question, or because the respondent exhibited free-rider tendencies. Although these observations were removed from the data set prior to performing the analyses reported below, it should be noted that the removal of these observations did not result in a statistically significant change in the average values associated with the three levels of control evaluated.

The contingent valuation results obtained from the adjusted data set, for the 60 percent reduction in late-season black flies, are reported in Table 6. Almost two-thirds of the households indicated that they placed zero value on a late-season black fly control that only achieved a 60 percent reduction. At the other extreme, 5.9 percent, or 19 of the households placed a value of greater than $25 per year on the program. The largest value expressed by a household for the 60 percent control was $250.

Table 6. Maximum Annual Value Households Place on a 60 Percent Reduction in Late-Season Black Flies.

	Respondents Expressing that Value	
Maximum Annual Value	Number	Percent
Zero	204	65.8
$0.01 to $5.00	18	5.7
$5.01 to $10.00	38	12.3
$10.01 to $25.00	31	9.9
$25.01 to $50.00	13	4.1
$50.01 to $100.00	5	1.5
More Than $100.00	1	0.3
Total	310	100.0

The average value associated with 60 percent control for all households in the survey is $7.61 per year, with a 95 percent confidence interval ranging from $5.41 to $9.81. That is, based on the information received from the sample, there is a 0.95 probability that the true population mean is between $5.41 and $9.81.

Multiplying the average household value determined from the sample by the number of households in the study area (7,836), yields an estimate of the total annual value all households in the study area place on a 60 percent reduction in late-season black flies of about $59,630. Using the upper and lower limits on the 95 percent confidence interval calculated above, the total amount residents would pay for a 60 percent reduction in late-season black flies is between $42,390 and $76,870. These represent the point and interval estimates of the benefits that would accrue to residents of the study area if control achieved a 60 percent reduction in late-season black flies.

The maximum annual values respondents place on a 75 percent reduction in the number of black flies are shown in Table 7. The distribution of responses is similar to that observed with 60 percent control. Again, almost two-thirds of the respondents placed a value of zero on a 75 percent reduction in the number of late-season black flies. Almost 11 percent valued the reduction at more that $25 per year. The highest annual value expressed by a household for the 75 percent reduction was $300.

The mean annual value for 75 percent control is $9.61, with a 95 percent confidence interval of $6.94 to $12.28. The average annual value for the 75 percent control is exactly two dollars higher than the average value for the 60 percent control.

The total value all households in the study area place on 75 percent control is about $75,300 (7,836 households x $9.61 per household). Based on

Table 7. Maximum Annual Value Households Place on a 75 Percent Reduction in Late-Season Black Flies.

	Respondents Expressing that Value	
Maximum Annual Value	Number	Percent
Zero	203	65.5
$0.01 to $5.00	11	3.5
$5.01 to $10.00	24	7.8
$10.01 to $25.00	39	12.6
$25.01 to $50.00	22	7.1
$50.01 to $100.00	10	3.2
More Than $100.00	1	0.3
Total	310	100.0

the upper and lower limits of the confidence interval around the mean, the total annual value has lower and upper bounds of $54,380 and $96,225, respectively. The annual value estimated for 75 percent control is about $15,700 or 25 percent higher than the annual value expressed for a 60 percent reduction in late-season black flies.

Sample respondents' annual values for a 90 percent reduction in late-season black flies are reported in Table 8. Almost 56.7 percent of the respondents still placed a zero value on 90 percent control, while 25 percent of the households expressed an annual value greater than $25. Six percent expressed an annual value greater than $50. The highest annual value reported for the 90 percent control level was $500. Clearly, residents place a higher value on the 90 percent reduction than they place on either the 60 or 75 percent reduction in late-season black flies.

The higher values are reflected in the average value of $15.61 for the 90 percent reduction, which is six dollars more than the average value reported for the 75 percent reduction. The 95 percent confidence interval around the mean is $11.52 to $19.70. Multiplying the average value by the number of households in the study area yields an estimated aggregate value for 90 percent control, of about $122,320 per year for all households in the study area. This is about $47,000 or 60 percent more than the value residents attach to a 75 percent reduction in late-season black flies. Using the lower and upper bounds on the confidence interval around the mean gives a range of $90,270 to $154,370 for the total value households place on 90 percent control.

Table 8. Maximum Annual Value Households Place on a 90 Percent Reduction in Late-Season Black Flies.

	Respondents Expressing that Value	
Maximum Annual Value	Number	Percent
Zero	182	56.7
$0.01 to $5.00	9	2.8
$5.01 to $10.00	31	9.7
$10.01 to $25.00	43	13.4
$25.01 to $50.00	36	11.2
$50.01 to $100.00	17	5.3
More Than $100.00	3	0.9
Total	321	100.0

Factors That Influence Economic Value

The data in Tables 6, 7, and 8 illustrate that different households place vastly different values on the reduction of late-season black flies. It is only

logical, therefore, to ask what factors influence the value a household places on late-season black fly control. To understand those factors or variables, responses for the 90 percent control level were regressed against selected socioeconomic characteristics of the household. Variables were chosen based on hypothesized associations with the household's stated value for black fly control.

Specifically, it was hypothesized that the number of people in the household and the income of the household would have a positive influence on the values expressed by households. That is, larger households, and households with higher incomes, would place a higher value on black fly control than smaller households and/or those with lower incomes. Similarly, it was hypothesized that households that required medical treatment of allergic reactions triggered by black flies, households that considered biting insects more bothersome than stinging insects, and households that considered late-season varieties of black flies more bothersome than early-season varieties would also have a positive influence on the values placed on 90 percent control. On the other hand, living greater distances from the river and taking steps to protect members from black flies were hypothesized to negatively influence the value residents place on control.

The results of the regression analysis are reported in Table 9. The independent variables and their hypothesized sign are recorded in the first two columns, and the actual sign and magnitude of the regression coefficient for the independent variable are shown in the third column of the Table. The last column indicates whether the regression coefficients are statistically significant at the 90 percent ($\alpha = .10$) level.

All of the coefficients, except the number of people in the household, have the same sign as hypothesized; only four of the coefficients, however, are statistically significant. They are household income, the need for medical treatment of allergies, whether other steps are taken to provide protection from black flies, and whether biting insects were considered more bothersome than stinging insects.

The statistically significant variables indicate that value increases by $.68 as household income increases by a thousand dollars, and that households that require medical treatment of allergies caused by black fly bites place a value of $18.18 more on control, on average, than the other households. Those households that consider biting insects most bothersome stated a value that averaged $9.69 more for 90 percent control than those that indicated stinging insects were most bothersome. Finally, those households that take other steps to protect members from black flies stated a value that is, on average, $12.32 lower than households that do not take steps to protect members.

Table 9. Factors that Influence the Value Households Place on a 90 Percent Reduction in Late-Season Black Flies.

Variable	Hypothesized Sign	Regression Coefficient	Coefficient Significant at $\alpha = .10$?
Miles from River to Residence	-	-.447	No
Household Income	+	.00068	Yes
Medical Attention Required for Allergy	+	18.18	Yes
Do You Take Steps to Protect Members	-	-12.32	Yes
Number of People in Household	+	-.218	No
Biting Insects Most Bothersome	+	9.69	Yes
Early/Late Season Most Bothersome	+	9.28	No
Intercept		-15.40	No

Number of observations = 320; $R^2 = .124$; $F = 5.51$; Significance of $F = .01$

Overall, the regression equation explains 12.4 percent of the variation in the data; however, the F-statistic for the equation is significant at the $\alpha = .01$ level, indicating that the equation explains a statistically significant amount of the variation in the values expressed by households for the 90 percent control level.

Finally, a separate analysis was performed to determine whether the average value residents of a community placed on 90 percent control was correlated with the number of late-season black flies in their community. During 1986 and 1987, researchers in the Department of Entomology at the University of Maine conducted field studies to determine the number of late-season black flies encountered at several locations within the study area. These black fly counts provided an indication of the level of infestation in several towns in the study area. A correlation analysis was performed between the the values residents of eight communities placed on 90 percent control and the density of the late-season black fly population in the communities. However, the correlation coefficient was not significant at the 90 percent ($\alpha = .10$) level.

The nonsignificant correlation may have been influenced by several fac-

tors. First, the severity of the black fly infestation varies greatly at different locations within and among towns in the study area, so the density of the black fly population at the sampling sites may not accurately reflect the severity of the infestation in the areas in which the respondents lived. In addition, the black fly counts in some towns were conducted in 1986, which may not reflect the severity of the infestation in 1987. Finally, the correlation analysis was performed with only eight pairs of data, which is much smaller than the number of pairs preferred for a correlation test. Therefore, one should not conclude, on the basis of the analysis conducted, that no relationship exists between the density of the late-season black fly population and the value residents attach to control of these pests.

V. SUMMARY AND IMPLICATIONS

Results indicate that black flies are the primary pest among all flying insects in the study area. This opinion was expressed by over 70 percent of the responding households. In comparison, mosquitoes and no-see-um's were identified as the primary pest by only 13.6 and 12.9 percent, respectively, of the households. Both early-season and late-season varieties were judged to be very bothersome. About ten percent of the persons in the households surveyed experienced allergic reactions to black fly bites, but only a few of these people required medical treatment, or could not work because of the allergy.

The average annual monetary value residents placed on late-season black fly control was relatively low, even though some households expressed large values for control. The low average is largely due to the fact that the majority of the households indicated that the three levels of control evaluated had no value to them. About 65 percent of the responding households indicated they placed no value on control that achieved a 60 and a 75 percent reduction in late-season black flies, and 57 percent placed a value of zero on 90 percent control. It is estimated that the value of 90 percent control for all households in the study area was only about $122,320 (about $16 per household). Consequently, the results of the survey can be viewed as contradictory in that black flies are a major pest, but residents, on average, place a relatively small value on control the late-season varieties.

Several factors may explain the apparent contradiction. For example, some respondents expressed skepticism about late-season black fly control. This skepticism was reflected in three ways. Some questioned whether it was physically possible to control the late-season black fly population in the study area. Others doubted whether control could be implemented without negatively impacting the environment, especially the fish populations in the river. Some indicated that black fly larvae are a food source for fish, and that the control of black flies could have an adverse effect on fish feeding habits. Finally, some residents were skeptical about the feasibility of controlling late-season black flies with a special control district. They thought the state should be involved in the control program and that it should help pay the costs associated with control. This form of skepticism suggests that the payment vehicle used to elicit values was at least partially rejected. All of these factors may partially explain why many households placed a zero value on control.

In addition, the low values associated with the 60 and the 75 percent control may indicate that these levels are insufficient to provide relief from the black flies. The average value for 90 percent control was more than twice

as large as the value for 60 percent control, and 60 percent larger than the average value for 75 percent control. Levels of control greater than 90 percent may result in significantly larger values for residents of the area.

Another factor that may partially explain the relatively low value attached to late-season black fly control by the sample households is that a large percentage of the people in the sample have resided in the area for relatively long periods of time. For example, the average age of the heads of households in the survey was 49 years, and they had lived in Penobscot County for an average of over 39 years. Therefore, on average, the respondents have experienced black flies for many years, and may have become accustomed to them.

Originally, it was hypothesized that the value that households placed on late-season black fly control was inversely related to the length of time they have lived in the area. An analysis of the data, however, indicated that the length of time the residents had lived in Penobscot County was not statistically significant ($\alpha = .10$) in explaining the value households attributed to 90 percent control of late-season black flies. Consequently, this variable was omitted from the regression equation reported in Table 9.

However, the nonsignificance of the length of time residents have lived in the Penobscot County in explaining the value they attributed to the contol of late-season black flies may be due to the unique characteristic of the population surveyed. About 92.5 percent of the households surveyed had been residents of Penobscot County for over 10 years, and 97.7 percent had been residents of Penobscot County for over five years. These time periods may be sufficient for residents to adjust to the presence of black flies, and, therefore, reduce the value they place on black fly control. If a higher percentage of residents had lived in the area for shorter time periods, the variable may have been significant.

Finally, the values obtained in the study are based on a control method that involved the introduction of the biological agent *Bti* into the river. Environmental concerns about the potential impact of this control agent may have also resulted in some people placing a zero value on control. Other methods of control that avoid the need to introduce chemical or biological control agents may be valued more highly than the method evaluated in this study.

It should again be noted that the costs of achieving the three levels of control were not estimated in this study. Therefore, this study can not assess the economic feasibility of control. However, it is possible to indicate the maximum costs that could be incurred to achieve the benefits reported above.

A pest control program is economically justified if the benefits that result from the program are greater than the costs. The annual benefits are esti-

mated to be $59,630, $75,300, and $122,320 for the 60, 75, and 90 percent levels of control, respectively. Therefore, the costs of achieving these levels of control have to be less than the reported benefits to be economically viable. A careful analysis of the costs of implementing the programs must be conducted before the economic feasibility of control can be determined. The level of control that can be achieved in the study area should also be determined, so the costs can be compared with the most appropriate level of benefits. If control levels of greater than 90 percent are found to be feasible, additional studies to determine the benefits associated with the higher levels of control should be undertaken.

Finally, it should be noted that the benefits estimated in this study apply to a specific study area and the people who live in that area. The results may be quite different for other regions of the state, other resident populations, or for other methods of control, or other types of pests. Consequently, one should not use these results to describe the attitudes toward black flies of all people in Maine or to infer the value other residents place on the control of late-season black flies or other pests.

REFERENCES

Anderson, G.D. and R.C. Bishop, 1986. "The Valuation Problem," In: *Natural Resource Economics: Policy Problems and Contemporary Analysis*, D.W. Bromley, ed., Boston: Kluwer Nijhoff, pp. 89-137.

Bauer, L.S. and J. Granett, 1979. *The Black Flies of Maine*, Technical Bulletin 95, Maine Life Sciences and Agriculture Experiment Station, University of Maine at Orono, (May), 18 pp.

Boyle, K.J. and R.C. Bishop, 1988. "Welfare Measurements Using Contingent Valuation: A Comparison of Techniques," *American Journal of Agricultural Economics*, 70:20-28.

Bureau of the Census, 1983. *1980 Census of Population and Housing*, Maine, Census Tracts, U.S. Department of Commerce, Series PHC80-2-21.

Bureau of the Census, 1986. *Northeast 1984 Population and 1983 Per Capita Income Estimates for Counties and Incorporated Places*, U.S. Department of Commerce, Series P-26, No. 84-NE-SC.

Cummings, R.G., D.S. Brookshire and W.D. Shulze, 1986. *Valuing Environmental Goods: An Assessment of the Contingent Valuation Method*, Totowa, NJ: Rowman and Allanheld, 270 pp.

Dickie, M., A. Fisher and S. Gerking, 1987. "Market Transactions and Hypothetical Demand Data: A Comparative Study," *Journal of the American Statistical Society*, 82:69-75.

Gibbs, K.E., F.C. Brautigam, C.S. Stubbs and L.M. Zibilske, 1986. *Experimental Applications of* B.t.i. *for Larval Black Fly Control: Persistence and Downstream Carry, Efficacy, Impact on Non-target Invertebrates and Fish Feeding*, Technical Bulletin 123, Maine Agricultural Experiment Station, University of Maine, Orono, October, 25 pp.

Greenley, D.A., R.G. Walsh and R.A. Young, 1985. "Option Value: Empirical Evidence from a Case Study of Recreation and Water Quality: Reply," *Quarterly Journal of Economics*, 100:295-299.

Heberlein, T.A. and R.C. Bishop, 1986. "Assessing the Validity of Contingent Valuation: Three Field Experiments," *The Science of the Total Environment*, 56:99-107.

John, K.H., J.R. Stoll and J.K. Olson, 1987. "An Assessment of the Benefits of Mosquito Abatement in an Organized Mosquito Control District," *Journal of the American Mosquito Control Association*, (March) 3:8-14.

Mitchell, R.C. and R.T. Carson, 1985. "Option Value: Empirical Evidence From a Case Study of Recreation and Water Quality: Comment," *Quarterly Journal of Economics*, 100:291-294.

Maine Department of Human Services, 1987. *Population Estimates for Minor*

Civil Divisions by County, Augusta: Office of Data, Research, and Vital Statistics, October, 34 pp.

Maine Department of Labor, 1987. *Labor Force Estimates for Minor Civil Divisions by Selected Area In Maine*, Augusta: Division of Economic Analysis and Research, Bureau of Employment Security, 35 pp.

Maine State Legislature, 1985. *Resolve, Concerning Black Fly Control*, H.P. 435 - L.D. 617, 1 p.

Ofiara, D.D. and J.R. Allison, 1985. "The Use of Present Value Criterion Applications in Making Mosquito Control Decisions," *Journal of the American Mosquito Control Association*, (October), 1:284-294.

"Pennsylvania Black Fly Suppression Effort," 1986. 7 pp.

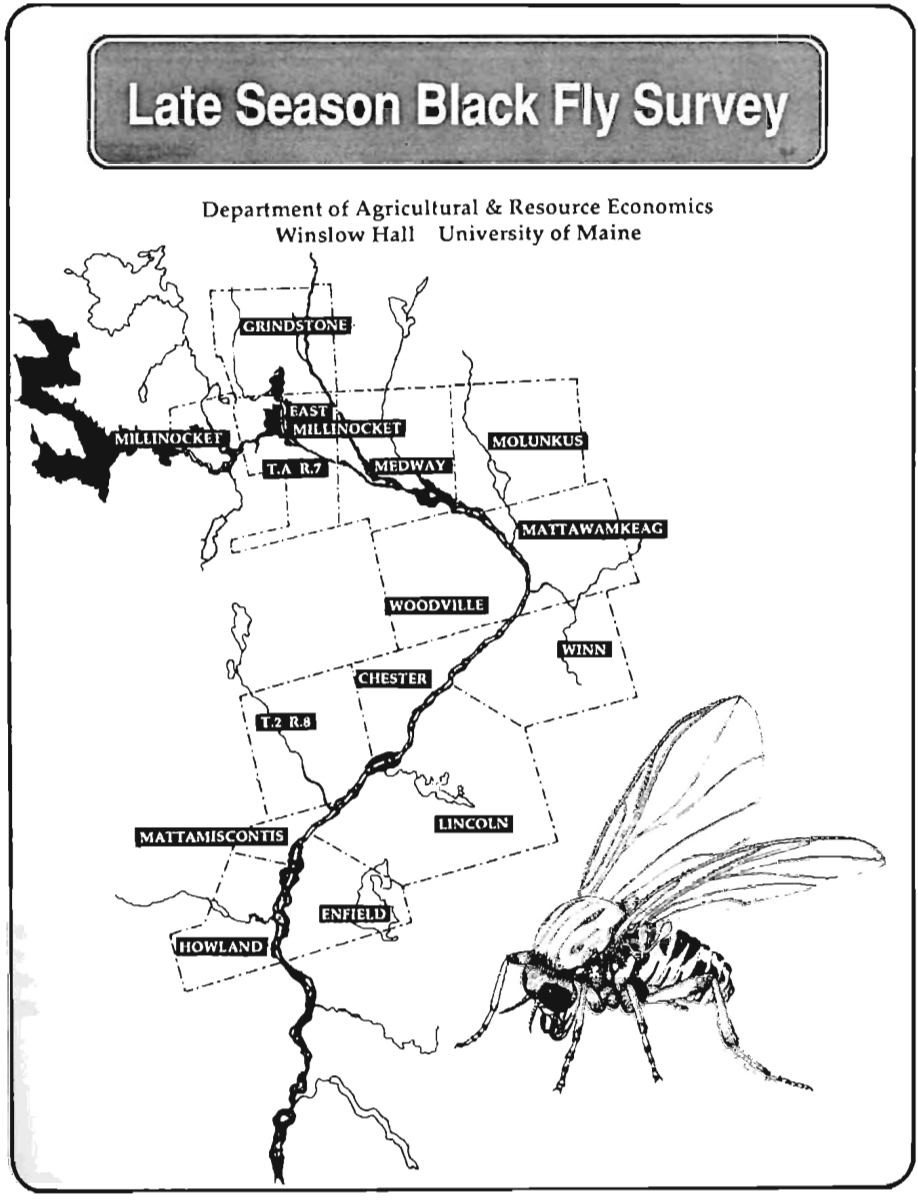
Scott, A., 1965. "The Valuation of Game Resources: Some Theoretical Aspects," *Canadian Fisheries Reports*, No. 4, Ottawa.

Sellar, C., J.R. Stoll and J.P. Chavas, 1985. "Validation of Empirical Measures of Welfare Change: A Comparison of Nonmarket Techniques," *Land Economics*, 61:156-175.

Smith, V.K., W.H. Desvousges and A. Fisher, 1986. "A Comparison of Direct and Indirect Methods for Estimating Environmental Benefits," *American Journal of Agricultural Economics*, 68:280-290.

Welsh, Michael P., 1986. "Exploring the Accuracy of the Contingent Valuation Method: Comparisons with Simulated Markets," Ph.D. Thesis, University of Wisconsin.

APPENDIX


Late Season Black Fly Survey
Department of Agricultural & Resource Economics
Winslow Hall University of Maine
GRINDSTONE
EAST MILLINOCKET
MILLINOCKET
MOLUNKUS
T.A R.7
MEDWAY
MATTAWAMKEAG
WOODVILLE
WINN
CHESTER
T.2 R.8
LINCOLN
MATTAMISCONTIS
ENFIELD
HOWLAND

UNIVERSITY OF MAINE

Department of Agricultural and Resource Economics

October 5, 1987

Dear Penobscot County Resident:

In 1985 the Maine State Legislature directed the Maine Department of Environmental Protection to investigate the possibility of controlling late season black flies that breed in the Penobscot River between Millinocket and Howland. Late season black flies appear in July, August and early September and are being studied because they only breed in the Penobscot River. In contrast, early season black flies, which appear in May and June, breed in most of the rivers and small streams in the area. Thus, control of the early season black flies (May and June) is much more difficult and expensive.

The Maine Department of Environmental Protection has asked the Department of Agricultural and Resource Economics at the University of Maine to determine how residents of the towns between Millinocket and Howland feel about black flies and to estimate the economic benefits associated with the control of late season black flies. You are one of more than 600 people that reside in the towns along the Penobscot River from Millinocket to Howland that we are contacting to learn more about residents' attitudes about black flies and the possibility of controlling late season black flies. It should take about 15 minutes to answer the attached questionnaire and it is important that the questionnaire be completed by the person to whom it is addressed.

Your answers will be kept in strict confidence. All results from the study will be based on all responses we receive from everybody in the study. The number written on the inside of the questionnaire will only be used to determine who has completed the questionnaire so we can avoid the expense of mailing additional copies of the questionnaire to those who have already returned it.

Your assistance is very important to us, to the Department of Environmental Protection and the Maine Legislature. Please take the time to answer the questions. This is your opportunity to provide information on the control of late season black flies along the Penobscot River from Millinocket to Howland. Please help us by completing this questionnaire. Tape or staple it closed and put it in the mail. No postage is required.

Thank you for your assistance and cooperation.

Sincerely Yours,

Stephen D. Reiling

Stephen D. Reiling
Associate Professor

P.S.: If you have any questions about the questionnaire, please call the University of Maine at 581-3154.

PART I
IN THIS SECTION OF THE QUESTIONNAIRE WE WOULD LIKE TO ASK SOME QUESTIONS ABOUT BLACK FLIES AND OTHER TYPES OF FLYING INSECTS

1. There are two types of flying insects that can be bothersome. There are the flying insects that **sting** (such as bees, hornets, wasps, etc.), and flying insects that **bite** (such as black flies, mosquitoes, deer flies, no-see'ums etc.). Please indicate which group of flying insects you personally consider to be the most bothersome by circling the number in front of the most appropriate response.

    1. Stinging insects that fly (bees, hornets, etc.) are the most bothersome
    2. Biting insects that fly (black flies, mosquitoes, etc.) are the most bothersome

2. Are you able to identify the different types of biting insects that fly, such as mosquitoes, deer flies, no-see'ums and black flies? (Circle the number in front of the correct answer.)

    1. Yes
    2. No (Skip to question 4)

3. Which one of the following **biting** insects that fly bothers you, personally, the most? (Circle the number in front of the one most bothersome flying insect listed below.)

    1. Mosquitoes
    2. Deer flies
    3. Black flies
    4. No-See'ums
    5. Other flying insects that bite (Please Specify)_____

    _____

4. For black flies, do you personally receive the greatest discomfort from the swarming of black flies around you or from the bites of black flies? (Circle the number in front of the most appropriate response.)

    1. Swarming is the biggest problem
    2. Biting is the biggest problem
    3. Both swarming and biting are major problems
    4. Neither swarming nor biting are major problems

5. Do you personally consider early season black flies (which exist in May and June) or late season black flies (which exist in July, August and September) to be the most bothersome? (Circle the number in front of the most appropriate response.)

    1. Early season black flies are the most bothersome
    2. Late season black flies are the most bothersome
    3. Both early and late season black flies are very bothersome
    4. Neither early nor late season black flies are bothersome

6. Please indicate **when** black flies bite you by circling the number in front of all responses that apply:

    1. When I am outdoors during daylight hours
    2. When I am inside or in a vehicle during daylight hours
    3. When I am outdoors after dark
    4. When I am inside or in a vehicle after dark
    5. Other (Please Specify) _____

    _____

7. Please describe the characteristics of the bite you receive from black flies by circling the number in front of each symptom that you experience. (Circle all that apply.)

    1. Swelling
    2. Itching
    3. Bleeding
    4 Red dot where bitten
    5. All the above
    6. Other (Please Specify) _____

    _____

8. What methods, if any, do you and other members of your household use for protection from black flies? (Circle the number in front of **all** methods used by your household for protection from black flies.)

    1. We do not do anything to protect ourselves from black flies (Skip to PART II of Questionnaire)
    2. Stay indoors as much as possible during black fly season
    3. Use a black fly repellant
    4. Use a "bug zapper"
    5. Leave the area during all or part of black fly season
    6. Wear light-colored clothing during black fly season
    7. Other (Please Specify: _____

    _____

9. How satisfied are you with the protection that the method(s) circled above provide? (Circle the number in front of the most appropriate response.)

    1. Very satisfied
    2. Somewhat satisfied
    3. Somewhat dissatisfied
    4. Very dissatisfied

PART II
THIS SECTION OF THE QUESTIONNAIRE IS DESIGNED TO DETERMINE IF ANY MEMBERS OF YOUR HOUSEHOLD SUFFER ALLERGIC REACTIONS TO BLACK FLY BITES

10. Do any members of your household suffer allergic reactions to black fly bites? (Circle the number in front of the appropriate response.)

    1. Yes

    2. No (Skip to question 15)

11. How many persons in your household suffer allergic reactions?

    _____ persons in my household suffer allergic reactions to black fly bites

12. Do any of these people that suffer an allergic reaction require medical attention (doctor visits and/or emergency room treatment) when bitten by black flies?

    1. Yes

    2. No (Skip to question 14)

13. Approximately how many doctor visits and/or trips to the emergency room were required in 1987 during the months of July, August and September for treatment of black fly bites? (If no trips to the doctor or emergency room were required, please record a zero in the space below.)

    _____ Number of trips to doctor or emergency room in **July, August and September of** 1987 for treatment of black fly bites

14. Please describe briefly the symptoms suffered by the person(s) with the allergic reaction to black fly bites. (extreme swelling, difficulty breathing, etc.)

_____

_____

_____

15. Please indicate the approximate amount of money, if any, your household spent during **July, August and September of 1987** for medical services (doctor visits, emergency room visits, etc.) and prescription and non-prescription drugs (calamine lotion, anti-itch creams, anti-histamines, etc.) for the treatment of black fly bites and any associated allergic reactions. (Please place a **zero** in the space below if your household did not pay any medical expenses for the treatment of black fly bites during these months of 1987.)

$_____ Approximate 1987 medical expenses due to black fly bites in **July, August and September**

16. Please indicate the approximate number of days during the months of **July, August** and **September** of 1987, if any, that members of your household could not work or perform normal activities because they had an allergic reaction to a black fly bite, and/or because they had to care for a person suffering from an allergic reaction caused by a black fly bite. (Please place a **zero** in the space below if members of your household did not lose any time from work or other normal activities due to black fly bites in July, August and September of 1987.)

_____ Approximate number of days lost from work or normal activities last year due to black fly bites in **July, August and September in 1987**.

Please continue on the next page.

PART III
NOW WE WOULD LIKE TO LEARN ABOUT HOW MUCH IT WOULD BE WORTH TO YOU AND YOUR HOUSEHOLD TO REDUCE THE NUMBER OF *LATE SEASON* BLACK FLIES. PLEASE READ THE FOLLOWING INFORMATION CAREFULLY BEFORE ANSWERING THE QUESTIONS IN THIS SECTION

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 affects 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.

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.

17. 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

18. Please indicate the **maximum annual fee** that your household would pay to the special district to reduce the number of **late season** black flies in your area by **seventy- five** (75) percent. (Please record a **zero** ($0) in the space below if you would not pay anything to reduce the number of **late season** black flies by 75 percent.)

    $_____ Maximum annual fee my household would pay for a **75 percent** reduction in **late season** black flies

19. Please indicate the **maximum annual fee** that your household would pay to the special district to reduce the number of **late season** black flies in your area by **ninety** (90) percent. (Please record a **zero** ($0) in the space below if you would not pay anything to reduce the number of **late season** black flies by 90 percent.)

    $_____ Maximum annual fee my household would pay for a **90 percent** reduction in **late season** black flies

20. Did you answer **zero** ($0) to Question 19? (Circle the number in front of the appropriate response.)

    1. Yes. (Go to Question 21)

    2. No. Which of the following responses best describes why you did not answer Question 19 as zero ($0)? (Circle the number in front of the most appropriate response.)

        1. I stated the most I can afford to pay for **late season** black fly control.
        2. For me, **late season** black fly control is worth exactly the amount I stated.
        3. I do not know how much I would really pay for late season black fly control, but I do want **late season** black flies controlled.
        4. I stated a high amount, more than I would pay, because I want the Depart - ment of Environmental Protection to know how important it is to me that **late season** black flies are controlled.
        5. I said a low amount, less than I would actually pay, because I want the black fly control program to be inexpensive.
        6. I said a low amount, probably less than I would actually pay, because I am concerned about the possible environmental impact of the late season black fly control program.
        7. I said a low amount, less than I would actually pay, because I think others will pay enough to cover the costs of the late season black fly control program.
        8. Other (Please Specify)_____

_____

Please skip to Part IV of the questionnaire

21. Which of the following responses best describes why you did answer question 19 as zero ($0)? (Circle the number in front of the most appropriate response.)

1. I do not want late season black flies controlled.

2. I can not afford to pay anything for black fly control.

3. I did not have enough information to determine how much I would pay.

4. I do not believe late season black flies can be controlled.

5. I do not know how much I would really pay for late season black fly control so I said zero.

6. I answered zero because I think others will pay enough to cover the costs of the late season black fly control project.

7. I answered zero because I am concerned about the possible environmental impacts of the late season black fly control program.

8. I answered zero because I don't like the use of a special district to raise the revenue for the late season black fly control program.

9. Other (Please Specify) _____

_____

Please continue on the next page.

PART IV
FINALLY, WE WOULD LIKE TO ASK A FEW QUESTIONS ABOUT YOU AND YOUR HOUSEHOLD AND THE ACTIVITIES YOU ENJOY SO WE CAN DETERMINE HOW THESE FACTORS MAY AFFECT RESIDENTS' ATTITUDES ABOUT BLACK FLIES AND THE POSSIBLE LATE SEASON BLACK FLY CONTROL PROGRAM.

22. Please indicate your age: _____ years old

23. Are you (Circle number in front of appropriate response):

    1. Male
    2. Female

24. How many persons reside in your household?

    _____ number of persons in household

25. Please indicate **the number of persons in your household** that are in each of the following age categories:

    _____ number of persons 18 years or older

    _____ number of persons less than 18 years old

26. Please circle the number in front of the category below that best describes the highest level of education that **you** have completed:

    1. 8 years or less
    2. Some high school education
    3. High school graduate
    4. Some technical school training or college education
    5. Technical school degree or two-year associate degree
    6. College degree (B.S., B.A., etc.)
    7. Some college graduate work
    8. Graduate degree (M.S., Ph.D., M.D., J.D., etc.)

27. Please circle the number in front of the category below that indicates your household's total income before taxes in 1986:

1. Less than $5,000	8. $35,000 - $39,999
2. $ 5,000 - $ 9,999	9. $40,000 - $44,999
3. $10,000 - $14,999	10. $45,000 - $49,999
4. $15,000 - $19,999	11. $50,000 - $54,999
5. $20,000 - $24,999	12. $55,000 - $59,999
6. $25,000 - $29,999	13. $60,000 - $74,999
7. $30,000 - $34,999	14. $75,000 or more

28. Circle the number in front of the statement that best describes your current employment status.

1. I am self employed
2. I am employed, full or part-time
3. I am unemployed
4. I am retired
5. Other (Please Specify) _____

_____

29. Please indicate your occupation. Be as specific as possible. If you are currently unemployed or retired, please report your former occupation.

Specific Occupation: _____

_____

30. How many years have you lived in Maine? _____ Years in Maine

31. How many years have you lived in Penobscot County? _____ Years in Penobscot County

32. How long have you lived at your current residence? _____ Years at Current Residence

33. How far from the Penobscot River is the residence to which this questionnaire was sent? (Please give us your best estimate of the **straight-line**, not **road** distance.)

_____ Mile(s) from the Penobscot River

34. We would like to know how often you and other members of your household participate in the following outdoor activities **at your home or within one mile of the Penobscot River** during the months of **July**, **August** and **September**. For each activity, please circle the response that most closely describes your behavior. (Circle one number for each activity whether you participate or not.)

	Often Do	Sometimes Do	Rarely Do	Never Do
Cook out / Picnic	1	2	3	4
Run / Jog	1	2	3	4
Hike / Walk	1	2	3	4
Bicycle	1	2	3	4
Ride ATV / Motorcycle	1	2	3	4
Lawn / Garden care	1	2	3	4
Camp	1	2	3	4
Fish	1	2	3	4
Hunt	1	2	3	4
Canoe	1	2	3	4
Boat	1	2	3	4
Swim	1	2	3	4
Observe wildlife	1	2	3	4
Sunbathe	1	2	3	4
Horseback riding	1	2	3	4
Play organized sports (softball,etc.)	1	2	3	4
Relax / Play games in yard	1	2	3	4

Other (Please Specify) _____

_____

35. Please circle the number in front of **all** of the organizations that you or other members of your household belong:

1. Natural Resources Council of Maine
2. Sportsman's Alliance of Maine
3. National Wildlife Federation
4. National Audubon Society
5. Maine Audubon Society
6. Sierra Club
7. Nature Conservancy
8. Ducks Unliminited
9. Trout Unlimited
10. National Rifle Association
11. Local Conservation Club (Fin & Antler etc.)
12. Other organization_____

_____

WE WELCOME ANY ADDITIONAL COMMENTS YOU HAVE ABOUT LATE SEASON BLACK FLIES AND THE POSSIBILITY OF CONTROLLING THEM. TO RETURN THE QUESTIONNAIRE, STAPLE OR TAPE IT CLOSED AND PUT IT IN THE MAIL. NO POSTAGE IS REQUIRED.

THANK YOU FOR YOUR ASSISTANCE.

_____ Please place an "X" here if you would like to receive a summary of the results of this survey