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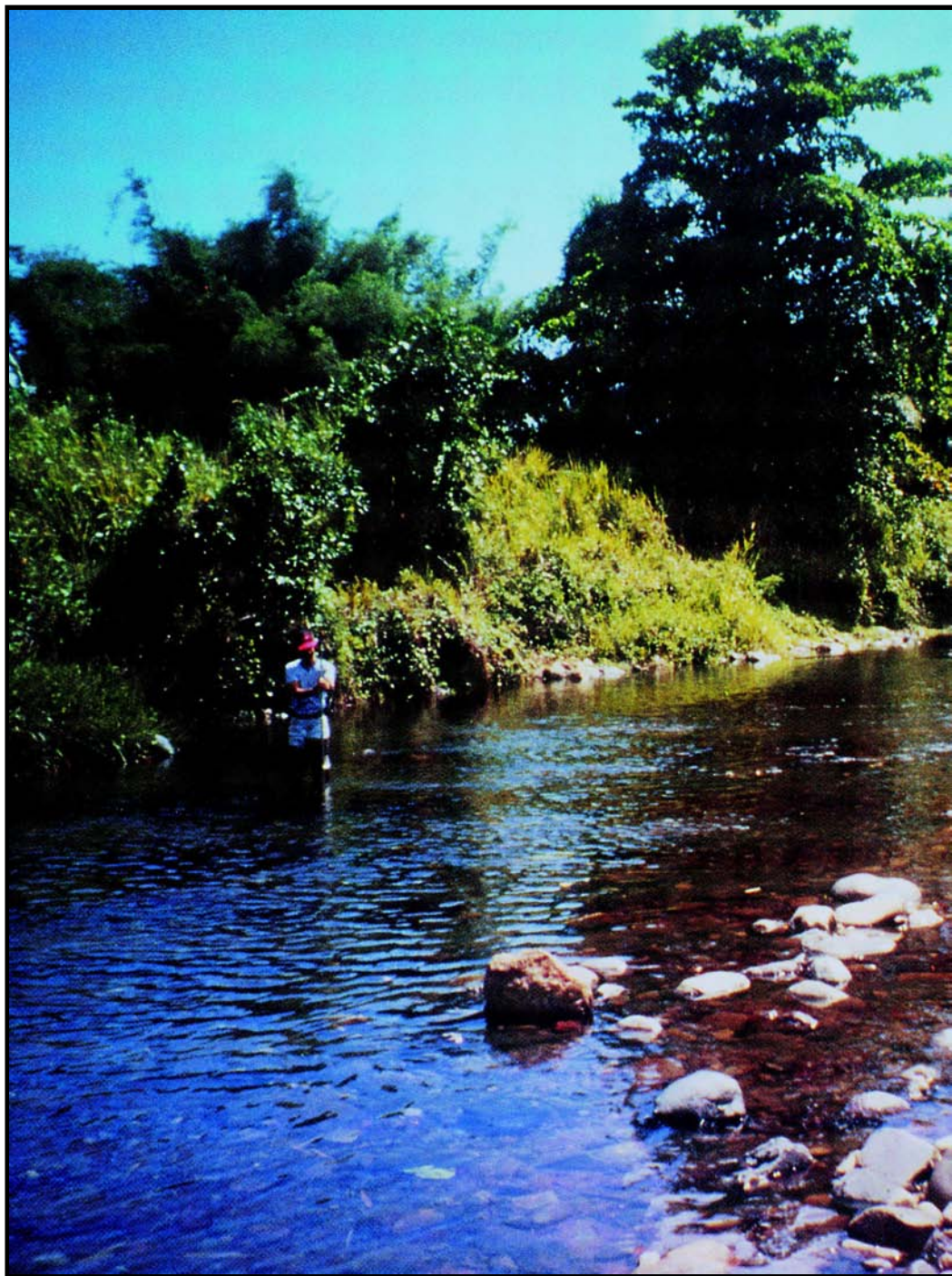
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Measuring the Economic Benefit of Maintaining the Ecological Integrity of the Río Mameyes in Puerto Rico

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Abstract

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A contingent valuation in-person survey of Puerto Rican households was performed from April to August 1995 to estimate their willingness-to-pay for preserving instream flows in the Río Mameyes and avoiding a dam on the Río Fajardo. Annual willingness-to-pay was \$21 for each river. When expanded to the 1 million households in Puerto Rico for the 5-year period households were asked to pay, this amount increased to \$110 million for the Ríos Mameyes and Fajardo. Visitors to the Río Mameyes indicated they would reduce trips by 93 percent if 10 million gallons daily were withdrawn from the river, resulting in a loss of \$250,000 in annual recreation benefits. Both the household and recreation values can be compared to the costs of repairing water lines and in-home water conservation measures to determine if there are more net benefits to these alternative sources of water than withdrawals from the Río Mameyes.

Retrieval Terms: benefit cost analysis, contingent valuation method, logit regression, recreation benefits, travel cost method, willingness-to-pay

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Retrieval Terms: benefit cost analysis, contingent valuation method, logit regression, recreation benefits, travel cost method, willingness-to-pay

The Puerto Rico Aqueduct and Sewer Authority's (AAA) proposal to withdraw up to 10 million gallons of water daily from the Río Mameyes in the municipality of Río Grande, Puerto Rico, caused an ongoing controversy. The Río Mameyes is the last pristine river remaining on the Island. This research is an effort to contribute to the understanding of the economic implications of projects such as that proposed by the AAA and the economic benefits to Puerto Rico of maintaining the ecological integrity of the Río Mameyes.

We quantified the total economic value to households in Puerto Rico of preserving the ecological integrity and riparian zone viability of the Río Mameyes via studying alternative flow levels in the river; the recreation use of the river as a function of river flow; and the total economic value to households in Puerto Rico of preserving flows and avoiding a dam on the Río Fajardo whose headwaters are in the Caribbean National Forest. We also investigated the substitution and complementary relationship between the Río Mameyes and the Río Fajardo.

We obtained a response rate of 40 percent for the households survey and 70 percent for the recreation survey. Maintaining the Río Mameyes and the Río Fajardo for future generations, for clean air and for protecting the environment, were some of the most important reasons given by households interviewed for caring about these rivers. Annual willingness-to-pay (WTP) for preserving instream flows in the Río Mameyes and avoiding a dam on the Río Fajardo was \$21 for each river. Expanding the WTP to the 1 million households in Puerto Rico for the 5-year period increased the amount to \$110 million. Visitors to the Río Mameyes indicated they would reduce their visits to the river by 93 percent if 10 million gallons were withdrawn daily from the river. This reduction in trips would result in an economic loss of \$250,000 in annual recreation benefits.

Introduction

In the 1990's the re-permitting and licensing of many current and proposed water resource projects have been based on ecological factors. In Puerto Rico this is demonstrated by the request from the Puerto Rico Aqueduct and Sewage Authority (AAA) to extract 10 million gallons of water daily (mgd) from the Río Mameyes, Barrio Palmer in Río Grande. Conflicts in the decisions over projects such as proposed for the Río Mameyes, the last pristine river in the area, are driven by society's growing awareness of the benefits of preserving the integrity of remaining ecosystems and the need to restore damaged ecosystems downstream. Failure to recognize the economic value of ecological integrity results in water supply agencies viewing natural resource agencies that oppose water diversions as wasting millions of dollars worth of water that could be put to beneficial use.

Maintaining existing and restoring damaged ecological integrity may often provide large market and non-market benefits. These can sometimes offset the loss of traditional commercial values of water. However, some biologists see maintaining ecological integrity as an overriding concern, even when the foregone commercial values of water are quite high. This concern suggests the need for an expanded benefit-cost framework for comparing the benefits of traditional uses of water with that of maintaining ecological integrity.

This paper discusses the results of our research project conducted from April to August 1995 to quantify the total economic value to households in Puerto Rico of preserving the ecological integrity and riparian zone viability in the Río Mameyes via alternative flow levels in the river (one measure of ecological integrity); quantify the recreation use value of the Río Mameyes as a function of river flow; quantify the total economic value to households in Puerto Rico of preserving flows and avoiding a dam on the Río Fajardo whose headwaters are on the Caribbean National Forest; and investigate the substitution and complementary relationship between the Río Mameyes and the Río Fajardo.

Basic Survey Format

The survey format for both heads of households and recreationists in the Río Mameyes is patterned after a California fire contingent valuation method (CVM) survey in terms of introductory questions, background information, proposals, alternatives, visuals, willingness-to-pay (WTP) questions, and demographics (Loomis and González-Cabán 1995). The heads of households survey has three individual programs and one combined program: there are two programs for the Río Mameyes, one for avoiding construction of a dam in the Río Fajardo, and another for a combined program of Ríos Mameyes and Fajardo. Each survey contains a detailed map showing the location of the rivers and the proposed projects, as well as graphs showing AAA current water production and distribution, current water flow in Río Mameyes, and how it would be affected by the proposed projects (*appendix A*).

Survey Development

Development of Technical Information on Rivers

Before beginning the survey design, we reviewed the available technical information on ecological integrity of rivers, ecosystems, and aquatic wildlife in and around the study rivers. In addition, we met with USDA Forest Service hydrologists, aquatic and wildlife biologists, and managers at the International Institute of Tropical Forestry (IITF) and the Caribbean National Forest (CNF) in Puerto Rico. They provided current information on the health of Ríos Mameyes and Fajardo ecosystems as well as information on the abundance and diversity of aquatic life in the rivers. Hydrological information and management regimes for the lands within CNF in which these rivers' headwaters are found was also provided.

We also met with personnel from the AAA to obtain information on the proposed plans and projects for both rivers, as well as water production and supply and demand for the San Juan Metropolitan area, which includes the area in which the river is found. They also provided information on population projections for the area. The U.S. Army Corps of Engineers provided us information about the proposed dam for the Río Fajardo. The U.S. Geological Survey (USGS) personnel gave us information on water records for both rivers for a period of 30 years showing minimum, average, and maximum flows; and other information relevant to communicate the present conditions of both rivers.

Focus Groups and Pre-testing

In total, four focus groups were held with small groups of Puerto Rico residents. One focus group was held in San Juan, covering the Metropolitan area of San Juan and the northeast region of the Island. A second focus group was held in Ponce, covering the southern region of Puerto Rico. The third focus group was held in Mayagüez and covered the western and northern part of the Island. The fourth and final focus group was held in Palmer, Río Grande. This group covered people from the areas immediately around the Río Mameyes and consisted only of people who recreate in the river on a regular basis. The purpose of these focus groups included discussion of what terms such as water flows, mgd, willingness-to-pay and water conservation trust fund meant to members of the general public and their perception of the effects of the proposed actions by the AAA on the Río Mameyes.

Each focus group consisted of about 12-15 persons representative of the general public. Hispania Research selected the individuals after carefully screening them for several criteria. For example, individuals had to be heads of households between the ages of 18 and 80. Individuals could not work for any Federal, Commonwealth of Puerto Rico, or municipal agencies that may have a direct or indirect impact on the decision regarding the proposed projects. For example, individuals working or associated with the AAA, Puerto Rico's Department of Natural Resources, the Planning Board, the Environmental Quality Board, or Federal agencies such as the Army Corps of Engineers, the Environmental Protection Administration, the Forest Service or the Fish and Wildlife Service were excluded from participation. Each focus group took between 3 to 4 hours to complete.

One of the primary objectives was to determine if our alternatives to the proposed actions by the AAA were understandable and realistic. We also checked for comprehension of our visual aids depicting the general location of the proposed projects and their effects on the river flows, and elicited suggestions for improving the quality of visual aids. Another objective was to discuss acceptable ways this program could be funded. The focus groups also provided us with a better understanding of the language that participants normally used to describe river-related events such as minimum and maximum water flows, and 10-years, 7-day average minimum flow.

After these focus group discussions, a complete survey script and visual aids were developed. A cadre of interviewers were trained in the proper techniques to conduct a personal interview and then the survey was pre-tested on a small sample (n=30) of Puerto Rico residents. During the pre-test we accompanied each one of the interviewers to ensure consistency and quality control of the interviews. During the interviews we repeatedly probed the respondent to determine if any features of the program descriptions, language, visual aids or questions were confusing or unclear. Finally, the pre-test was used to refine the range of bid amounts for the dichotomous choice WTP questions.

Survey Structure

Non-monetary Measures of Relative Importance

Before directly asking how much respondents would pay for a program that maintained the ecological integrity of Ríos Mameyes and Fajardo, it was important to allow the respondents an opportunity to reflect on why they might care about these rivers. Cummings and others (1986) refer to this technique as research on personal preferences or in other words, collecting one's thoughts on a topic. Residents of Puerto Rico have been repeatedly exposed to media coverage of water rationing and related problems, particularly in the San Juan Metropolitan Area. This was certainly true during 1994 when Puerto Rico experienced one of the most severe droughts of the past 30 years. Metropolitan San Juan suffered the brunt of the problem during that year. In addition, the government declared a state of emergency for the AAA, which was widely publicized both in television and print media.

The first set of questions of the survey asked about the relative importance of the Ríos Mameyes and Fajardo for recreational use, as habitat for aquatic life, wildlife and plants, a source of jobs, and providing scenic beauty. A five-point Likert scale allowed individuals to rate the relative importance of these various reasons for valuing these two rivers. This neutral response format (that precedes the dollar valuation questions) aided in understanding the WTP responses that individuals provided later in the survey.

Steps in Developing a Contingent Valuation Survey

Any CVM survey design involves three elements: portrayal of the resource to be valued, description of the particular financial mechanism to be used to pay for the resource, and the question format used to elicit the respondent's dollar amount of WTP.

In this case there were four programs to be valued: Program 1 to avoid the extraction of 10 mgd of water from the Río Mameyes and maintain the current conditions; Program 1A that would withdraw water but guarantee a minimum flow of 5 mgd of water in the Río Mameyes at all times; Program B to avoid the construction of a dam on the Río Fajardo; and Program C that combines protection of the Ríos Mameyes and Fajardo. Respondents were reminded of the location of the rivers at risk during the interviews by use of a map that shows the location of the rivers and the proposed projects (*appendix A, fig. 1*).

A page describing the proposed actions by the AAA was given to the person interviewed so he/she could follow the interviewer reading it to him/her. The material referenced in the reading was then shown to interviewees. This material described in detail the proposals by the AAA and the possible consequences they would have on the river flows. We developed alternative ways to convey the extent of the effect of the AAA proposals after discussions in our focus groups with participants on how to make such effects meaningful. After the focus groups, we refined the elements for all the programs that were listed in the questionnaire. We described the actions in Program 1 for the Río Mameyes by explaining:

The Puerto Rico Aqueduct and Sewage Authority is considering two proposals for extracting water from the Río Mameyes. The first option is the extraction of 10 mgd of water from the Río Mameyes to supply the present and future needs of the cities of Luquillo, Río Grande, Canóvanas, Loíza, San Juan, and the proposed hotel complex close to Río Mar. The second option is the extraction of water from the river but guaranteeing at least a minimum flow of water of 5 mgd. As you can see on Map 1 (*appendix A, fig. 1*), the proposed water intake will be close to Route 3 (65th of Infantry Ave.) in the town of Palmer. Therefore,

downstream from the water intake, the river will suffer a reduction in the level of water.

The rest of the material described in detail two graphs showing the effects of the AAA proposals. The complete questionnaire was read to all interviewees. The entire questionnaire and all interviews were in Spanish.

The alternative to the AAA proposal, Program 1, was described to respondents as:

To avoid the Extraction of 10 mgd of Water from the Río Mameyes: Through a water conservation trust fund, a Water Commission, independent of AAA, would establish a program to repair the water distribution lines throughout the whole Island, and would provide low flow shower heads and toilets to 50,000 Puerto Rican families for installation in their homes.

The effect of Program 1 on the Río Mameyes flow was illustrated by a line graph showing different levels of water flow as a result of extracting 10 mgd of water from the river (*appendix A, fig. 2*). The graph was also described verbally. Respondents were told that if they chose not to pay, during the months of April, June, and December, the Río Mameyes could dry-up in periods of 7-days minimum water average flow (*appendix A, fig. 2*).

Program 1A emphasized reducing the water consumption of the families by providing them more efficient shower heads and toilets, and improving the agency's water system efficiency by providing funds specifically for repair of the water distribution lines. This program contained the same elements as Program 1, but it guaranteed a minimum flow in the river of 5 mgd of water. As in Program 1, the consequences of Program 1A were represented via a line graph and discussed with respondents during the interview process (*appendix A, fig. 3*).

A great deal of discussion in focus groups and in pre-testing emphasized ways of communicating the differences between the 7-day minimum water average flow, the average water flow, and the flow after the proposal. The result was a refinement of the graphs and chart used in the survey.

Program B was to avoid the construction of the dam in the Río Fajardo and entailed repairing the water distribution lines, as in the previous two programs. In addition, this program would also require dredging the La Plata and Lago Carraizo Dams and increasing their storage capacity by the same volume proposed for the Fajardo Dam. These two dams are the main water sources for Metropolitan San Juan.

Program C was a combined program to avoid extraction of 10 mgd of water from the Río Mameyes and avoid construction of a dam on the Río Fajardo. This program offered respondents the opportunity to avoid both projects proposed by the AAA by contributing to the water trust fund, administered by a Water Commission, independently of the AAA, which would use the funds for repairing water distribution lines, provide low flow shower heads and toilets to 100,000 Puerto Rican families to install in their homes, and to dredge both the La Plata and Lago Carraizo Dams.

In all the Programs presented to survey respondents they were told that implementing the alternative measures discussed would make available to the AAA enough additional water to make the proposed projects unnecessary. In addition, they were told that the options described are very expensive and more money is needed to implement them. To defray the cost of the alternatives, all recreationists using the public lakes, forest reserves, and developed public beaches would have to pay an increase in the entrance and parking fee to these areas. Even then the money would not be enough and that is why they would need to contribute additional money to implement the programs through a check-off on their Puerto Rico income tax return.

The check-off would be patterned after the non-game and other payment options that are on many state income tax forms (e.g., California, Colorado, Oregon). Although the check-off approach is certainly not familiar to Puerto Rico residents, the approach of a contribution to trust funds have been used on the Island for decades to fund land conservation projects. The most prominent example of this is the Fideicomiso de Conservación de Terrenos (Land Conservation Trust Fund). This trust fund was originally established with public funds but soon thereafter became totally independent and is financed through individual and corporate donations. Half the respondents received a statement that reminded them to consider their household budgets, and substitute or competing environmental programs, when indicating whether they would pay their bid amount. This is referred to as the "budget reminder" in the rest of the report.

The WTP question format asked each household to pay a particular dollar amount each year for 5 years. In this case, the individual must decide if the value to him or her of the program is at least worth this price or not. The dichotomous choice format is recommended by the Blue Ribbon panel on CVM (Arrow and others 1993).

The exact text of the script read to respondents was:

The proposals for the extraction of water from the Río Mameyes and the construction of a dam on the Río Fajardo has been proposed at the same time. But as indicated, implementing the programs described could supply water for the next 30 years without the need to build any of the proposed projects.

1. Repairing the water distribution lines and reduction on the number of illegal connections to the water distribution lines.
2. Increase the storage capacity of reservoirs by dredging and removal of sludge and sediments.
3. Provide 100,000 Puerto Rican families with efficient shower heads and toilets for installation on their homes that consume less water.

Any of the three alternatives of water supply presented here would eliminate the need for construction of water intake on the Río Mameyes, with the resulting water reduction in the river water level that this entails and the construction of a new dam on the Río Fajardo.

Nevertheless, these three options are very expensive and additional funds are needed to implement the selected alternative. To defray the cost of implementing a program, all recreationists using public lakes, forest reserves and developed public beaches in Puerto Rico, would pay an increase in the entrance and parking fees for using these facilities.

The funds collected from the increase in the entrance and parking fees to recreationists will be given to a water conservation trust fund, administered by a water commission independent of AAA. This commission will be responsible for implementing a program to solve the water rationing problems. Members of the water commission will not be paid for managing the trust funds. By law, the trust fund money could not be used for any other purposes than those specified in the creation of the fund.

The increase described above, however, would not be enough to defray the cost of implementing a program to repair the water distribution lines, dredging of the reservoirs and providing 100,000 Puerto Rican families with efficient shower heads and toilets to install in their homes. An additional

contribution from all Puerto Rican families is needed to solve the problem.

After reading this description to the respondents, we asked them the WTP questions:

Taking into account this situation, we would like you to answer the following questions. Would you pay \$XX more for the next 5 years to the water conservation trust fund for implementing Program X, which includes repairing the water distribution lines and installing 100,000 Puerto Rican homes with efficient shower heads and toilets that consume less water so that water would not be extracted from the Río Mameyes? If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1 (*appendix A, fig. 2*).

YES _____ NO _____

A similar series of WTP questions were asked for all programs (1, 1A, B and C). If the individual responded YES, the dollar amount was doubled (\$XX). If the individual responded NO, the dollar amount was reduced by half. If the individual indicated they would not pay this lower bid amount, then they were asked if they would pay \$1. Stepping the respondent up or down is known as the double-bounded dichotomous choice approach (Hanemann and others 1991) and has been shown to substantially reduce the variance of WTP. Addition of a lower bound at \$1 has been proposed by Hanemann and Kristrom (1994) for the single-bounded logit, but Loomis and González-Cabán (1995) appear to be the first to use it for the double-bounded dichotomous choice. The gain in statistical efficiency arises from the series of WTP questions, which allows the researcher to bracket many of the respondent's WTP between two of the dollar bid amounts. Welsh and Bishop (1993) call this general approach of multiple bid amounts, the multiple-bounded approach and have developed a GAUSS (programming language) routine to estimate the resulting likelihood function.

Recreation Survey

The same basic wording and series of WTP questions were also used to ask the WTP question for the recreation survey conducted at the Río Mameyes. Visitors were first asked their trip cost. They were then asked their willingness-to-pay higher trip costs to visit the Río Mameyes. Specifically, they were asked if they would still visit the Río Mameyes today, if their cost were \$XX higher than what they already spent on that visit. If they said NO, the dollar amount was reduced by half. If they said NO to this amount, they were asked if they would pay \$1 more to visit. If they said YES to the initial amount, the dollar amount was doubled and they were asked if they would pay this increase in costs. If they said YES to this doubled amount, they were asked if they were certain that they would pay this doubled amount. If they still responded YES, the bid amount was multiplied by their annual number of visits to compute an annual WTP. They were then asked if they would really pay this annual amount to continue to visit the Río Mameyes under current conditions. If they said no, they were then asked an open-ended question requesting their maximum WTP per visit to the Río Mameyes.

In addition to asking WTP for their current trip, we showed respondents graphs 1 and 1A (*appendix A, figs. 2, 3*) of the Río Mameyes with Program 1 (10 mgd withdrawals) and Program 1A (withdrawals with a guaranteed 5 mgd minimum flow). We asked recreationists how their visits would change with Program 1 and 1A. They could indicate visits would increase, decrease, or stay the same. If they stated visits would increase or decrease, they were asked by how many trips.

Estimation of the Multiple-Bounded Model

Each respondent was asked to consider at least two different dollar amounts, and they were asked up to three if they said no to the first and no to the second. Our question sequence included five possible response combinations: (1) $Py_i y_u$; (2) $Py_i n_u$; (3) $Pn_i y_l$; (4) $Pn_i n_l y_{\$1}$; (5) $Pn_i n_l n_{\$1}$, in which subscript i is the initial dollar amount asked, subscript u is the upper dollar amount asked, l is the lower dollar amount asked, and $\$1$ is the lowest dollar amount asked of individuals that said no to the lower dollar bid amount.

Response patterns two to four bracket the respondent's WTP between two of the bid amounts they were asked. If the program is not viewed by respondents as reducing their well being (i.e., they either would benefit from the program if it were offered for free or simply do not care one way or the other about the program), the fifth response category is bracketed by zero (*fig. 1*).

<-----				
upper	initial	lower	\$1	0
\$ amt	\$ amt	\$ amt	\$ amt	
(1) $Py_i y_u$	(2) $Py_i n_u$	(3) $Pn_i y_l$	(4) $Pn_i n_l y_{\$1}$	(5) $Pn_i n_l n_{\$1}$

Figure 1—Five possible response combinations to willingness-to-pay questions.

Using a multiple bounded approach to calculate the specific dollar amount a person would pay involves estimating the probability density function only over the bracketed interval. The log likelihood function is:

$$(1) \ln (\text{Likelihood}) = \sum_{r=1}^n \ln (Pr_u - Pr_l)$$

in which, Pr_u and Pr_l are the probabilities that respondent r would pay their upper dollar amount (u) and lower dollar amount (l), respectively. The only difficulty is dealing with response category #1, in which the yes-yes response does not allow us to observe an upper bound on the individual's WTP. However, we do know, with probability =1, that the respondent's WTP is larger than the upper amount. Welsh and Bishop (1993) use this observation to program the log likelihood function for this first response category.

For ease in computing the log likelihood function, the probability density function of WTP is often assumed to be logistically distributed (*fig. 2*). The log likelihood function is maximized with respect to the parameters (B 's) explaining the pattern of responses observed. At a minimum the parameters include the bid amount the individual is asked to pay. Additional parameters may include responses to attitude questions or the respondent's demographics such as age, education, membership in environmental organizations, etc.

From equation 1, Hanemann (1989) provides a formula to calculate the expected value of WTP if WTP must be greater than or equal to zero. The formula is:

$$(2) \text{Mean WTP} = (1/B1) * \ln (1+\exp Bo) \text{ where WTP} > 0$$

in which $B1$ is the coefficient estimate on the bid amount and Bo is either the estimated constant (if no other independent variables are included) or the grand constant calculated as the sum of the estimated constant plus the product of the other independent variables times their respective means.

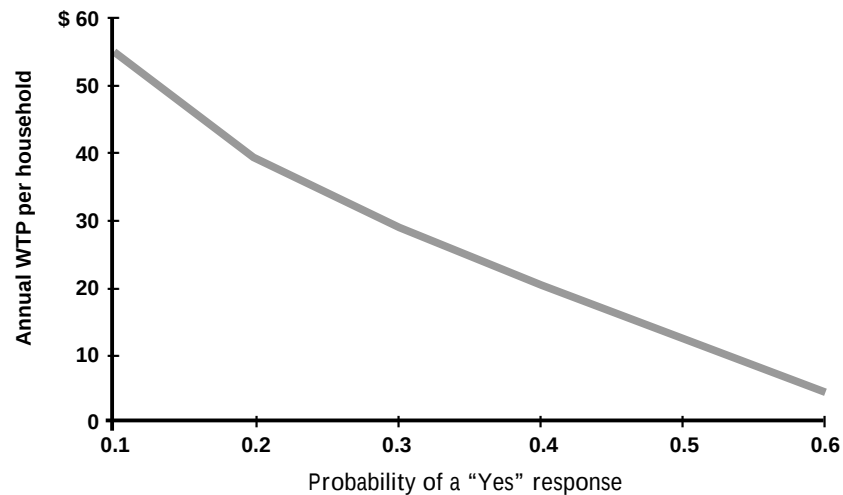
If some respondents view the AAA proposals as beneficial, then their WTP to exclude the projects could be negative (i.e., they would need to be compensated for not implementing the projects). To allow for this, we used an alternative formula provided by Hanemann (1989) that allows part of the logit curve to fall into the negative quadrant. With a linear logit model this mean WTP allows for

negative WTP of some individuals to be equal to the median. Equation 3 provides this alternative formula:

$$(3) \text{ Median WTP} = B_0/B_1$$

In the household survey, 15 different bid amounts ranging from \$5 to \$225 were randomly assigned to survey respondents. The range was picked such that at the low end, anyone that thought that the proposed projects by AAA would affect Ríos Mameyes and Fajardo ecosystems would very likely indicate they would pay \$5, while almost no one was expected to pay \$225 per year. In the recreation survey the bid amounts were \$5 per trip to \$120 per trip at the high end. These initial or starting bid amounts were based on responses to discussion in the focus groups and pre-testing of the survey questionnaire.

Figure 2—Puerto Rico households' willingness-to-pay (WTP) function for the Río Mameyes: Program 1.



Statistical Testing of Hypotheses

To test whether WTP for each program is statistically different from zero and whether WTP is different between geographic regions or programs, two statistical techniques were used. The most direct test is to estimate confidence intervals around mean WTP by using the variance-covariance matrix (Park and others 1991). If the confidence interval for the program does not include zero, then mean WTP is statistically greater than zero. When comparing two programs, if their confidence intervals do not overlap we can conclude these programs are statistically different (Poe and others 1994). If confidence intervals overlap, a more rigorous test of whether the two distributions of WTP are significantly different can be performed using the method of convolutions (Poe and others 1994).

To check the representativeness of our respondents against the Island population, demographic questions such as age, education, membership in environmental organizations, and income were asked. The final survey script had nine legal size pages (*appendix A*).

Sample Design

Household Sample Frame

The sample frame consisted of clusters of housing units classified according to geographic regions, areas, and economic level. The three classification variables and their corresponding relative weights were determined:

<i>Region</i>	<i>Relative weight (pct)</i>
Grand San Juan	45
San Juan sub-region	15
Ponce	15
Mayagüez	15
Arecibo	10
Total	100

<i>Areas¹</i>	<i>Relative weight (pct)</i>
Urban	75
Rural	25
Total	100

¹ As defined by the U.S. Bureau of Census

<i>Economic levels¹</i>	<i>Relative weight (pct)</i>
Very high (A)	5
High (B)	10
Middle (C)	35
Low (D)	30
Very low (E)	20
Total	100

¹ This is an Economic Indicator developed by Hispania Research using the following formula: $IE = P\left(\frac{V}{1000}\right) + Q\left(\frac{R}{5}\right) + \left(\frac{Y}{200}\right)$ in which; IE is the economic indicator, P is the proportion of owner-occupied houses, Q is the proportion of renter-occupied houses, V is the median value of owner-occupied houses, R is median rent paid by renters, and Y is the median family income.

Sample Selection

By using proportionate sampling, 60 clusters (sampling points) were selected with probability proportionate to size controlled by the classification variables. In each cluster, 10 eligible persons were interviewed. The resulting distribution of clusters (sampling points) were determined (*tables 1, 2*).

In each cluster or sampling point of 10 effective interviews, 5 "bidding values" with reminder statement and 5 "bidding values" without reminder were systematically randomly assigned, balancing for gender classification. At the geographic region level, the systematic selection system was used to control a balanced number for the 15 "bidding values" and 2 reminding systems.

The results of the selection assignment were determined (*table 3*). For each of the 30 bidding and reminding system combinations, we obtained 20 interviews balanced by gender, for a total effective sample size of 600.

Selected households were screened with respect to several criteria. This included age 18 and over but less than 80 years. Households that worked for Federal or Commonwealth natural resource, water, or planning agencies were excluded from selection. Interviews were conducted during the months of April, May, and June of 1995.

Table 1—Sampling points in rural areas.

<i>Region</i>	<i>Number of sampling points</i>
Grand San Juan	4
San Juan sub-region	3
Ponce	3
Mayagüez	3
Arecibo	2
Total	15

Table 2—Sampling points in urban areas.

<i>Region</i>	<i>Economic level</i>					<i>Total</i>
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	
Grand San Juan	1	2	6	6	4	19
San Juan sub-region		1	2	2	2	7
Ponce	1		2	2	2	7
Mayagüez		1	2	2	2	7
Arecibo		1	2	1	1	5
Total	2	5	14	13	11	45

Table 3—Sample selection assignment by gender and reminding system.

<i>Cluster sample</i>	<i>San Juan San Juan</i>	<i>Sub-Region</i>	<i>Ponce</i>	<i>Mayagüez</i>	<i>Arecibo</i>
<i>N =</i>	230	100	100	100	70
A1 ¹	7 (4f/3m) ²	4 (2f/2m)	3 (2f/1m)	3 (1f/2m)	3 (1f/2m)
B1	7 (3f/4m)	4 (2f/2m)	3 (1f/2m)	3 (2f/1m)	3 (2f/1m)
C1	7 (4f/3m)	4 (2f/2m)	3 (2f/1m)	3 (1f/2m)	3 (1f/2m)
D1	7 (3f/4m)	4 (2f/2m)	3 (1f/2m)	3 (2f/1m)	3 (2f/1m)
E1	7 (4f/3m)	4 (2f/2m)	3 (2f/1m)	3 (1f/2m)	3 (1f/2m)
F1	8 (4f/4m)	3 (2f/1m)	3 (1f/2m)	4 (2f/2m)	2 (1f/1m)
G1	8 (4f/4m)	3 (1f/2m)	3 (2f/1m)	4 (2f/2m)	2 (1f/1m)
H1	8 (4f/4m)	3 (2f/1m)	3 (2f/1m)	4 (2f/2m)	2 (1f/1m)
I1	8 (4f/4m)	3 (1f/2m)	3 (1f/2m)	4 (2f/2m)	2 (1f/1m)
J1	8 (4f/4m)	3 (2f/1m)	3 (2f/1m)	4 (2f/2m)	2 (1f/1m)
K1	8 (4f/4m)	3 (1f/2m)	3 (1f/2m)	4 (2f/2m)	2 (1f/1m)
L1	8 (4f/4m)	3 (2f/1m)	3 (2f/1m)	4 (2f/2m)	2 (1f/1m)
M1	8 (4f/4m)	3 (1f/2m)	3 (1f/2m)	4 (2f/2m)	2 (1f/1m)
N1	8 (4f/4m)	3 (2f/1m)	3 (2f/1m)	4 (2f/2m)	2 (1f/1m)
O1	8 (4f/4m)	3 (1f/2m)	3 (1f/2m)	4 (2f/2m)	2 (1f/1m)
A2	7 (4f/3m)	4 (2f/2m)	3 (2f/1m)	3 (1f/2m)	3 (1f/2m)
B2	7 (3f/4m)	4 (2f/2m)	3 (1f/2m)	3 (2f/1m)	3 (2f/1m)
C2	7 (4f/3m)	4 (2f/2m)	3 (2f/1m)	3 (1f/2m)	3 (1f/2m)
D2	7 (3f/4m)	4 (2f/2m)	3 (1f/2m)	3 (2f/1m)	3 (2f/1m)
E2	7 (4f/3m)	4 (2f/2m)	3 (2f/1m)	3 (1f/2m)	3 (1f/2m)
F2	8 (4f/4m)	3 (2f/1m)	3 (1f/2m)	4 (2f/2m)	2 (1f/1m)
G2	8 (4f/4m)	3 (1f/2m)	3 (2f/1m)	4 (2f/2m)	2 (1f/1m)
H2	8 (4f/4m)	3 (2f/1m)	3 (2f/1m)	4 (2f/2m)	2 (1f/1m)
I2	8 (4f/4m)	3 (1f/2m)	3 (1f/2m)	4 (2f/2m)	2 (1f/1m)
J2	8 (4f/4m)	3 (2f/1m)	3 (2f/1m)	4 (2f/2m)	2 (1f/1m)
K2	8 (4f/4m)	3 (1f/2m)	3 (1f/2m)	4 (2f/2m)	2 (1f/1m)
L2	8 (4f/4m)	3 (2f/1m)	3 (2f/1m)	4 (2f/2m)	2 (1f/1m)
M2	8 (4f/4m)	3 (1f/2m)	3 (1f/2m)	4 (2f/2m)	2 (1f/1m)
N2	8 (4f/4m)	3 (2f/1m)	3 (2f/1m)	4 (2f/2m)	2 (1f/1m)
O2	8 (4f/4m)	3 (1f/2m)	3 (1f/2m)	4 (2f/2m)	2 (1f/1m)

¹ A to O = “bidding values.”

1 = inclusion of the budget reminder.

2 = budget reminder not included.

² f = female; m = male.

Recreation Users

Recreation users were sampled at two locations: at the mouth of the river (figs. 3, 4) and near the proposed water intake area (figs. 5, 6). The proposed water intake site on route 191, south of Route 3 (appendix A, fig. 1), will be referred to as the restaurant site because it is next to a closed restaurant. Surveys at the restaurant site were performed on half the weekends in July and August as well as 2 holidays and weekdays for a total of 12 days during 1995. Surveys at the mouth of the river were conducted on half the weekends in July as well as 2 holidays and 2 weekdays for a total of 9 days during 1995. Recreation users were interviewed on-site. Selection criteria were the same as for the household survey, except for age that was from 16 to 80 years, to account for driving age. Most visitors were using the river for swimming, diving, picnicking, etc. One person from every group present at the site during the survey period (10 a.m. to 5 p.m.) was interviewed (this person was often the driver).



Figure 3—At the mouth of the Río Mameyes, recreationists were surveyed, such as fisherman Roberto Hernández and his son Roberto Hernández who were casting their crab traps.



Figure 4—Horseback riders, enjoying the cool and refreshing waters at the mouth of the Río Mameyes, were also surveyed.

Figure 5—At the proposed water intake area, we surveyed a family swimming in the Río Mameyes.



Figure 6—Some recreationists we surveyed visited the Río Mameyes at the proposed water intake area to picnic and relax and enjoy the tranquillity and beauty of the area.



Results

Household Response Rate

In total, 600 household interviews covering 47 municipalities throughout the Island were completed, for a response rate of 40 percent (600/1,495). Interviewers visited the areas selected for sampling and walked from house to house until the total number of interviews needed were completed. If the house visited was vacant, the interviewers would move to the next house in the block and that house would not be counted as an attempt. If nobody answered or there was a response but the person who answered refused to participate in the survey, that visit was counted as an attempt and included as part of the sample frame. Households excluded from the survey because of one or more of the screening criteria were not counted as part of the sample frame. To achieve the 600

interviews desired, a total of 1,495 attempts were made. As a standard procedure, 30 percent of the respondents were called back to certify that they were interviewed and to verify their responses. The 40 percent participation rate is somewhat lower than desirable, but knowing the negative image that the AAA has with the public, the lower participation rate is not surprising.

The demographics of the sample were compared to demographics of Puerto Rican households (*table 4*). The household sample was found to consist of older respondents (by 8.6 years) than the population level, and they were slightly more educated (by about 1 year). Our sample had a slightly larger proportion of males (50 percent male) as compared to the population proportion (48.4 percent). Our sample income was less than the population income. Even with such a carefully designed sample procedure, the sample obtained was not completely representative of the population at large. We adjusted our WTP estimates by the education variable by using a logistic regression.

Table 4—Comparison of demographic characteristics of sample households to Puerto Rico households.

Variable	Sample	Puerto Rico
Age	49.84	41.25
Education	11.49	10.54
Income	\$12,535.00	\$13,777.00
Percent male	50.00	48.40

Recreation Response Rate

During the months of July and August, 1995, a total of 274 recreation users were contacted and 200 interviewed for a response rate of 73 percent (200 interviewed / 274 contacted). Recreation users were contacted at the mouth of the Río Mameyes and near a closed restaurant along road PR-191 leading to the Caribbean National Forest. Visitors were screened for minimum age of 16 and no more than 80 years old. In addition, we did not interview visitors who had been previously interviewed at the recreation site.

Attitudes Toward Rivers and Prior Knowledge

Respondents were asked why rivers such as the Río Mameyes and the Río Fajardo might be important to households and visitors (*table 5*). The most important reasons given by households include (in order of importance), maintaining rivers for future generations, for clean air, protecting the environment, preservation of plants and animals, protecting natural beauty, water supply, and protecting fish habitat.

The respondents were asked about their knowledge regarding the Río Mameyes and the Río Fajardo before being interviewed. On a 3-point scale, in which 1 was a great deal of knowledge, 2 was a small amount, and 3 was nothing, household average of previous knowledge was 2.35 for the Río Mameyes and 2.46 for the Río Fajardo. Recreation users knowledge of the Río Mameyes was 2.15. This low level of previous knowledge among recreation users was surprising, but the river was not signed at the highway and the recreation sites were undeveloped and unsigned. The higher knowledge for the Río Fajardo as compared to the Río Mameyes may have been because the Río Fajardo crosses a major town (Fajardo) while the Río Mameyes does not.

Table 5—Attitudes toward the importance of rivers.¹

<i>Reason</i>	<i>Household</i>	<i>Visitor</i>
Preservation of plants and animals	4.75	4.75
Natural beauty	4.75	4.86
Recreation	4.46	4.73
Wildlife	4.64	4.78
Source of jobs for fisherman	4.26	3.83
Clean air ²	4.81	4.86
Cultural	4.37	4.36
Tourism	4.43	4.53
Water supply	4.74	4.36
Food	4.40	4.21
Preserve for future generations	4.82	4.83
Protection of environment	4.79	4.86
Define the rural area	4.12	N/A
Habitat for fish	4.68	4.68

¹ Coding: Very important = 5
Important = 4
Moderately important = 3
Slightly important = 2
Not important = 1

² The high value given to clean air may be due in part to the association people may be making between the river and the clean air near the river. Overall, the air quality around the river is very high and people may be giving a high mark to air quality based on their experience in the river area.

Checking the Respondent's Acceptance of the Hypothetical Market Scenario

As is standard in the contingent valuation method, a follow-up check question was asked after the WTP question to determine if those refusing to pay an amount over \$1 was a valid representation of their value or reflects a protest about some feature of the hypothetical market (Mitchell and Carson 1989). In both the household and visitor survey, the question was asked as an open-ended question. In the household survey, the question was "Please state the principal reason you would not pay or would only pay \$1 for these programs." The interviewer could then check one of six precoded response categories or "other" (which was subsequently coded into an additional six categories).

Two categories represented valid refusals or zero's and were considered non-protests. These categories were "the program has no value to me" and "I cannot afford to pay at this time." The absolute number of responses and the percent of total interviews in the household sample were calculated (table 6). There was only one protest in the visitor survey, so no further discussion is necessary. Only 20 household respondents out of the 600 households (3.3 percent) gave the first reason and 171 (28.5 percent) gave the second. Responses in the second category (cannot afford to pay) were particularly encouraging as it meant that respondents took the commitment to pay seriously.

Most of the remaining categories represent what are usually classified as protest or scenario rejection responses. These included "I don't think the program would work" with just 23 responses (3.83 percent), "It is unfair to expect me to pay" with 22 responses (3.67 percent), "The water agency (AAA) should pay" with 137 responses (22.8 percent), "I am opposed to any new government programs" with 6 responses (1 percent) and "Would only contribute \$1 to the trust fund so there is water for everyone" with 15 responses (3 percent).

Many of the protest responses are usually not considered valid representations of the individual's willingness to pay or benefits from maintaining instream flow in the two rivers, though they may represent valid

concerns regarding financing of water conservation in Puerto Rico. These responses are normally not included when WTP is computed (Mitchell and Carson 1989).

In general the percentage of protests responses was higher than desirable. This may reflect the general public dislike and distrust towards the water agency in Puerto Rico (AAA). The agency's poor performance during the 1993-94 drought reinforced this attitude in the public. It is apparent from the interview results that the AAA does not have a good reputation amongst Puerto Rico's citizens. To be conservative, we include all respondents in the analysis that follows, even protest responses. This will understate WTP, as some people who refused to pay for water programs may have a positive WTP to maintain instream flow in the Río Mameyes or avoid a dam on the Río Fajardo, but did not believe the money they would pay would actually be used for the water conservation program described or they thought that AAA should pay.

Table 6—Distribution of responses to willingness-to-pay questions.

	<i>Number</i>	<i>Pct of sample</i>
<i>Agreed to pay the first or second bid amount</i>	<i>193</i>	<i>32.02</i>
Reasons why households would not pay or would pay only \$1:		
The program has no value to me	20	3.33
My economic situation does not allow me to pay	171	28.50
I do not believe the program would work	23	3.83
It is unfair to expect me to pay	22	3.67
I am opposed to any new government programs	6	1.00
Water agency (AAA) should pay	137	22.83
Program does not address needs of this area	3	0.50
Metropolitan San Juan should pay for own water system	1	0.17
If it is a fair price, I would pay something	2	0.33
Not a problem here, no drought	1	0.17
Would only contribute \$1 to the trust fund so there is water for everyone	15	3.00
Doesn't believe funds would be used for water conservation program	2	0.33
Other Reasons		

Statistical Analysis

Logit Equations

Calculation of mean WTP from the multiple dichotomous choice WTP data involved use of a maximum likelihood approach applied to a logistic distribution (Welsh and Bishop 1993). The coefficients and t-statistics for the multivariate logit equations for the entire data set were calculated, including protest responses for the two Río Mameyes programs, the Río Fajardo program, and the combined Río Mameyes and Río Fajardo program (*tables 7-10*).

All of the coefficients on the bid amount are negative and statistically significant at the 0.01 level. The negative sign on the bid amount indicates the higher the dollar amount they were asked to pay, the less likely they would pay for the water conservation program. This demonstrates that the respondents were concerned about the dollar amount they were asked to pay, otherwise the likelihood of responding yes would have been invariant (and insignificant) with respect to the dollar amount. Demographic variables such as education and income were both significant. However, since education and income were positively correlated and income consistently had an incorrect negative sign, education was used in the logistic regression. Region of the island where the respondent lived was also statistically significant. As might be expected, the further away the respondent lived from the two study rivers and the less affected by the water shortage, the less likely they would pay for protection of these rivers (Sanders and others 1990). Using the Wald's statistic, all equations estimated were statistically significantly different from zero.

We calculated the household mean and median WTP for the Río Mameyes, the Río Fajardo, and the combined program for both rivers (*table 11*). The statistical efficiency of the multiple-bounded approach is evident as the 95 percent confidence intervals are quite tight. The mean and median values per household are \$21 and \$13 for Program 1. The median suggests that 50 percent of the population would pay \$13 for Program 1A. Two-thirds of the households surveyed would pay at least \$1 for all of the programs options presented to them. We also found strong substitution effects and budget constraints (*table 11*), which results in WTP for the Combined Program C (\$23) being just slightly larger than the two individual programs that make up the Combined Program. This suggests that the two individual programs for the Río Mameyes and the one for the Río Fajardo are not additive.

As part of the analysis, we performed a logistic regression to test the National Oceanic and Atmospheric Administration (NOAA) panel (Arrow and others 1993) recommendation that individuals be reminded of the competing demands on their limited budget. The rationale is that when people are reminded of their limited budget they would tend to be more conservative in their response to the WTP question. The null hypothesis is that the budget reminder has no effect on the WTP (Loomis and others 1994). The alternative hypothesis is that it should have a negative effect. That is, the coefficient of this variable is either zero or negative. In our case, the budget reminder dummy variable (1 if reminder present, 0 if not) was consistently significant and with a positive sign. This result would indicate that as people were reminded of their budget limitations, they were willing to pay more for protection of the Río Mameyes. This is contrary to theory, and the variable was not investigated further.

Table 7—Multiple-bounded logit regression for the Río Mameyes Program 1.¹

Variable	Coefficient	Standard error	T-statistic	P-value
Constant	0.648943	0.241797	2.683838	0.007
Region	-0.225754	0.048928	-4.614024	0.000
Education	0.050866	0.017334	2.934422	0.003
Bid (\$)	-0.051259	0.002482	-20.652111	0.000

¹ Wald Statistic: 430.763039
Probability of a larger Wald Statistic: 0.000000
Observations: 600 Degrees of freedom: 597

Table 8—Multiple-bounded logit regression for the Río Mameyes Program 1A.¹

Variable	Coefficient	Standard error	T-statistic	P-value
Constant	0.689101	0.243137	2.834214	0.005
Region	-0.205377	0.049050	-4.187097	0.000
Education	0.038204	0.017348	2.202159	0.028
Bid (\$)	-0.05090	0.002502	-20.382143	0.000

¹ Wald Statistic: 418.828872
Probability of a larger Wald Statistic: 0.000000
Observations: 600 Degrees of freedom: 597

Table 9—Multiple-bounded logit regression for the Río Fajardo dam Program B.¹

Variable	Coefficient	Standard error	T-statistic	P-value
Constant	0.590185	0.241123	2.447649	0.015
Region	-0.213689	0.048898	-4.370060	0.000
Education	0.046876	0.017326	2.705576	0.007
Bid (\$)	-0.049418	0.002426	-20.369996	0.000

¹ Wald Statistic: 419.589443
Probability of a larger Wald Statistic: 0.000000
Observations: 600 Degrees of freedom: 597

Table 10—Multiple-bounded logit regression for the Ríos Mameyes and Fajardo combined Program C.¹

Variable	Coefficient	Standard error	T-statistic	P-value
Constant	0.683510	0.240462	2.842991	0.005
Region	-0.229313	0.048752	-4.703670	0.000
Education	0.044705	0.017178	2.602408	0.009
Bid (\$)	-0.045654	0.002217	-20.590050	0.000

¹ Wald Statistic: 428.405051

Probability of a larger Wald Statistic: 0.000000

Observations: 600 Degrees of freedom: 597

Table 11—Household mean and median annual willingness-to-pay for the Río Mameyes and the Río Fajardo Programs.

Variable ¹	Río Mameyes		Río Fajardo	Ríos Mameyes and Fajardo
	Program 1	Program 1A	Program B	Combined Program C
Mean	\$20.92 (\$19-23)	\$20.36 (\$18-22)	\$20.73 (\$19-23)	\$22.84 (\$21-26)
Median	\$12.75 (\$10-16)	\$11.78 (\$9-15)	\$11.74 (\$9-15)	\$13.35 (\$11-17)

¹ 95 percent confidence interval.

Recreation Users

The multiple-bounded logit regression was determined for recreation users (*table 12*). All of the slope coefficients were statistically significant at the 0.05 level or higher. The signs of the variables are quite plausible. In particular the longer the visitor stayed at the river, the more they were willing to pay for their visit. The bid amount is negative, implying that the higher the increase in trip costs visitors were asked to pay, the more likely they would not pay.

Using the logit regression (*table 12* and *equation 1*), we calculated visitors would pay \$52 per group, which converts to \$10.93 per visitor to the Río Mameyes and determined by using an observed group size of 4.75. The 95 percent confidence interval is \$47 to \$58. In the probing of visitors that answered YES to both bid amounts, we found only 6 out of 94 switched to a lower WTP when asked if they were sure they would pay this cost per trip. Of these six people, five out of the six lowered their WTP by \$10-20 per group. When the question was rephrased as an annual WTP for all their trips to the Río Mameyes, an additional 3 out of the 94 reduced their WTP. One reduced by \$5 per trip (from \$20 to \$15), one by \$10 (from \$40 to \$30), and one by \$30 (from \$80 to \$50). It is encouraging that visitors seem to have a well established value for recreating at the Río Mameyes.

We also screened annual WTP amounts against income levels. Out of the 200 visitors, 31 reported annual WTP that was greater than 4 percent of their income. Although this may be plausible for some nearby residents of towns such as Fortuna where 40-60 visits per year were not uncommon, we chose to be conservative and eliminated per trip responses that when multiplied by annual number of trips implied WTP in excess of 4 percent of reported income.

Table 12—Multiple-bounded logit regression for recreationists.

Variable	Coefficient	Standard error	T-statistic	P-value
Constant	0.772	0.508	1.519	0.131
Onsite time	0.074	0.029	2.540	0.012
Age	0.028	0.012	2.267	0.025
Travel time	0.014	0.005	2.776	0.006
Bid amount	-0.045	0.005	-11.925	0.000

When asked how their trip-making behavior would change with Program 1 and 1A, the majority of visitors indicated a major reduction in trips. With 10 mgd withdrawals that could dry up the Río Mameyes in two months of the year (April and June), visitors stated they would reduce their visitation by 93 percent. With Program 1A, the reduction is 82 percent of their annual visits.

Our survey revealed that the recreationists visited the Río Mameyes to participate in different kinds of recreational activities (*figs. 3-10*). Jet ski operators have been using the river more, and because of this, they often entered into conflict with fishermen and swimmers (*fig. 10*). Horseback riding was also another popular activity at the river mouth (*fig. 4*). During three or four visits to the mouth of the river, we noticed that the recreational activities were river-dependent (*figs. 3, 7, 10*). Picnicking was also very popular in the river, particularly in the stretch of river near a closed restaurant on Route 191 (*fig. 6*). This area was preferred for picnicking and even camping because of the vegetation cover that provides shade (*fig. 8*).



Figure 7—Swimming is one of the favorite activities at the mouth of the river.



Figure 8—Scenery around the river near the proposed water intake area in Route 191.

Expanding The Sample Values To Population Estimates

Household Sample

When expanding the sample to the population, one critical concern is the external generalizability of the sample values to the population. This depends on the representativeness of the sample frame and the survey response rate. As described earlier, our sample frame is a stratified sample to represent geographic regions, urban/rural areas as well as economic levels of Puerto Rico households. The response rate was 40 percent.



Figure 9—Jet skis posed a serious problem to both fishermen and swimmers alike.



Figure 10—Jumping from the top of the tree in the background is one of the most attractive features on this part of the river.

In spite of the careful sampling design, our survey respondents were older, with about 1 year more of education but substantially lower income (approximately \$1,200) than Puerto Rico households as a whole. In preliminary logit regressions with both income and education, the sign of the income variable became negative. A correlation analysis showed that income and education were statistically significantly correlated, causing the negative and incorrect sign in the income variable. Given this situation we chose to use education instead of income as an explanatory variable. *Tables 7-10* show that education is positively related to WTP; thus, we will use our estimated WTP in *table 11*.

The 1990 Census indicates there are 1.059 million households on the Island. Applying the mean WTP value per household (*table 11*), we calculated the three total economic value estimates (*table 13*). The low estimate is calculated by applying the WTP estimate to 40 percent of Puerto Rico's households for all four programs. This provides an annual WTP estimate per household. The assumption for this low estimate is that since only 40 percent of the households contacted participated in the survey, the other 60 percent of the households will have a zero value for the programs described in the survey. This is a very conservative approach. The middle estimate is obtained by adjusting the WTP estimate by Puerto Rico's household average education, which lowers the WTP estimate by about \$1, and multiplying it times the Island total number of households. The high estimate is the WTP estimate (*table 11*) times the Island total households. The high estimates assume that the rest of the households will have the same WTP for the programs as those who participated in the survey.

The annual estimates were multiplied by the 5-year period respondents were asked to pay for the total 5-year WTP for the programs.

The estimated values ranged from a low of \$8.6 million a year for Program 1A to a high of \$24.19 million for the Combined Program C for the Ríos Mameyes and Fajardo (*table 13*). The 5-year estimate ranged from a low estimated of \$43 million for Program 1A to a high of \$120.94 million for the Combined Program C for the Ríos Mameyes and Fajardo.

The WTP estimates of Puerto Rico's households for maintaining flows at the Río Mameyes are in the middle range when compared to WTP estimates in the United States of America for maintaining river flows or protecting rivers (*table 14*). For example, Sanders and others (1990) estimates for protecting rivers in the State of Colorado ranged from \$39 annually per household for protection of 3 rivers to a high of \$101 annually per household for protection of 15 rivers. Brown and Duffield (1995) estimates for maintaining flows in different rivers in Montana ranged from \$6.70 annually per household for protection of one river to \$12.43 annually per household for protection of five rivers.

Table 13—Total annual and 5-year willingness-to-pay of Puerto Rico households for the Río Mameyes and Río Fajardo programs.

Variable	Río Mameyes		Río Fajardo	Ríos Mameyes and Fajardo
	Program 1	Program 1A	Program B	Combined Program C
	(\$ millions)			
Annual mean WTP				
Low estimate	8.90	8.62	8.78	9.70
Middle estimate	21.50	21.06	21.35	23.55
High estimate	22.20	21.60	21.95	24.19
5-year WTP				
Low estimate	44.50	43.10	43.60	48.50
Middle estimate	107.50	105.30	106.75	117.76
High estimate	111.00	108.00	109.75	120.94

Table 14—Comparison of WTP estimates for the Río Mameyes to WTP estimates for maintaining flows and protecting rivers in Colorado and Montana.

Variable	Total annual willingness-to-pay					
	3-Rivers	15-Rivers	Río Mameyes	Río Mameyes and Río Fajardo	1-River	5-Rivers
	(dollars)					
Colorado	39.00	101.12				
Puerto Rico			20.92	22.84		
Montana					6.70	12.43

Recreation

The economic loss of recreation due to water withdrawals as described in Program 1 or 1A is computed by taking the reduction in trips times the WTP per trip (\$10.93; *table 15*). Due to the undeveloped nature of the recreation sites along the Río Mameyes, actual on-site counts of visitors are not available. We developed three approaches to estimating total visitor use at our two sample sites (this understates total use along the affected section of the Río Mameyes because other sites are not included). The first estimate of loss is purely based on our sample of survey responses (*table 15*). Survey respondents indicated they took 12,130 trips a year to the Río Mameyes. A conservative estimate of the loss would be to generalize from sampled visitors, ignoring users who came during non-sampled periods during the summer months. Thus, a 93 percent reduction in trips results in 11,240 trips lost,

which would be worth \$122,853 annually. Using this same method, Program 1A would result in 9,982 fewer trips for a loss of \$109,103 annually.

The middle estimate still takes a conservative approach but recognizes that our sample only represents about 1.5 months of the summer season (*table 15*). If we expand this to the full summer season of 3 months, this would involve doubling our sampled trips. Performing this calculation there would be 24,260 total annual trips, with a loss of 22,480 trips worth an estimated \$245,706 annually. Finally, we expanded our sample to a yearly visitation rate by expanding the sample based on days surveyed over the summer and using respondent-reported annual number of trips per visitor (12.67). This yields 70,961 trips with a loss of 65,755 trips under Program 1 and a loss of 58,898 trips under Program 1A. This represents an annual loss of \$718,702 and \$643,755 for Programs 1 and 1A, respectively.

Table 15—Annual recreation losses on the Río Mameyes with Programs 1 and 1A.

Variable	Low		Middle		High	
	Program 1	Program 1A	Program 1	Program 1A	Program 1	Program 1A
Current trips	12,130	12,130	24,260	24,260	70,961	70,961
Trip loss	11,240	9,982	22,480	19,893	65,755	58,898
Annual recreation value lost	\$122,853	\$109,103	\$245,706	\$218,027	\$718,702	\$643,755

Conclusion and Further Research

The contingent valuation method was used to obtain estimates of willingness-to-pay for preserving the ecological integrity of the Río Mameyes and Río Fajardo. We obtained a 40 percent response rate for the household survey and over a 70 percent response rate for the visitor surveys. Using the dichotomous choice WTP question format, the annual value per household in the sample was \$21 to prevent 10 mgd extraction from the Río Mameyes and implement repair of the water distribution system lines and in-home water conservation program in Puerto Rico. Households would also pay \$21 per year to avoid a dam on the Río Fajardo and implement dredging of the two major reservoirs to the San Juan metropolitan area. For a combined program protecting both rivers, the households WTP was \$23. Generalizing to the Island as a whole and over the 5 years they were asked to pay, this represents an economic value that ranges from a low \$44.50 million to a high of \$111 million for the Río Mameyes, from \$43.60 to \$106.75 million for the Río Fajardo, and from a low of \$48.50 to a high of \$120.94 million to protect both rivers. Thus, the contingent valuation method appears to be a promising approach to analyzing the values associated with preserving the Ríos Mameyes and Fajardo because it measures a broader range of societal concerns about maintaining the instream flow and associated environmental quality of rivers in Puerto Rico.

AAA should consider alternative ways to meet the future water demands of Puerto Rico, including those described in the survey. These include repairing the water lines and reducing illegal connections, dredging of the Carraizo and La Plata reservoirs to restore their water storage capacity, and replacing water inefficient shower heads and toilets. Implementation of these alternatives can help the agency to reduce the unaccounted for water losses from about 40 percent to about 15 percent. This saving translates into over 10 times more water than what they are planning to extract from the Río Mameyes.

The values estimated in this survey are likely to be indicative of values held by Puerto Rican households for preserving other rivers and maintaining water quality in rivers throughout the Island. In particular, our results may be suggestive of the economic values at risk if wastewater treatment plants

are constructed on rivers, which could lead to a deterioration in water quality in the rivers that have water extracted from them. The combined effect of substantial water withdrawals and increased effluent discharge is likely to result in a serious decline in water quality. This decline would likely adversely affect recreational use of the river and ecological health and integrity of the natural system. However, to estimate the economic losses associated with deterioration of water quality in Puerto Rico's rivers would require site specific economic studies.

The puzzling finding of a positive sign associated with the budget reminder variable should be investigated further. Theory indicates that this variable should have no effect or a negative effect on the WTP estimates. In previous research this variable has been found to have zero effect on WTP estimates (Loomis and others 1994).

Finally, this survey demonstrates the existence of an underlying mistrust in any new proposal considered to come from the government. This mistrust seems to increase greatly when the new proposals are associated with the AAA. It is apparent that the people of the Island do not believe the AAA can resolve Puerto Rico's water problems in an efficient and credible manner. This particular issue should be investigated further to determine if the findings we observed are agency-dependent or a general phenomenon on the Island. Studies using other environmental goods not associated with the AAA, such as the Puerto Rican parrot, can provide a good avenue to test the hypothesis.

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Appendix A – Survey Questionnaire

WEATHER CONDITIONS (Note the day conditions)

Hot _____	Sunny _____	Humid _____
Warm _____	Cloudy _____	Dry _____
Cold _____	Rainy _____	Windy _____

INTERVIEW LOCATION

Mouth of the river _____	Restaurant _____	
Starting time: _____	Date: _____	#Questionnaire: _____

Hello, my name is _____. I work for Hispania Research Corporation and I am doing this survey on behalf of the USDA Forest Service. You have been randomly selected to be interviewed, and I request a few minutes of your time to complete the survey. Thanks.

(If refuse to participate, please tally) 1/2/3/4/5/6/7/8/9/10 or more

A. Have you or any member of your family been interviewed before about the Río Mameyes?

Yes: _____ (Stop interview, mark tally) No: _____

1/2/3/4/5/6/7/8/9 or more

B. Do you work in any of the following agencies? **(Stop interview if answer yes to any.)**

	No	Yes	
Department of Natural Resources	1	2	(Stop)
Fish & Wildlife Service	1	2	(Stop)
Aqueduct and Sewer Authority	1	2	(Stop)
Forest Service	1	2	(Stop)
Planning Board	1	2	(Stop)
Army Corp of Engineers	1	2	(Stop)
Governor's Office	1	2	(Stop)
Environmental Quality Board	1	2	(Stop)

C. Did you arrive by car? Yes No Walking **(Go to Q-F)**

D. Who drove the car in which you got here?

You? _____ **(Go to Q-F)** Other person _____ **(Identify this person and ask Q: A & B)**

E. Sex **(By observation, check quota)**

Female: ___1 Male: ___2

F. Please indicate your age group **(Hand out card)**

Less than 16 years	(Stop)
16 - 24 years	1
25 - 34 years	2
35 - 44 years	3
45 - 54 years	4
55 - 64 years	5
65 - 70 years	6
71 - 75 years	7
76 - 80 years	8
80 +	(Stop)

First, let me give you a short description about the river.

Description of the Río Mameyes

The Río Mameyes headwaters start atop of El Yunque mountain in the Caribbean National Forest. At present it flows uninterrupted for 7.5 miles meandering through the town of Palmer until reaching the Atlantic Ocean as can be seen in Map 1 (**show Map [fig. 1]**). The Río Mameyes is one of the last rivers in Puerto Rico and the Caribbean that flows freely through all existing ecosystems from the rain forest atop the mountains to the coastal plains, wetlands and mangroves. This river has the highest number of species or biodiversity of all rivers in the El Yunque area. These species include several species of native fishes and shrimps.

Some stretches of the Río Mameyes have been designated by the United Nations as Biosphere Reserve. To protect the beauty of this river, the USDA Forest Service, Caribbean National Forest Management Plan has recommended that 3.6 miles of the Río Mameyes be designated as “natural” or “scenic” under the Scenic and Natural Rivers Act of the Federal Government.

Now, I would like to know more about the importance of the Río Mameyes. People have different reasons to worry about the rivers in Puerto Rico: for some the rivers are important because they provide food or recreation; for others, because they provide them with peace and quiet; and for others, the ecological value of the rivers. And for you, why is this river important?

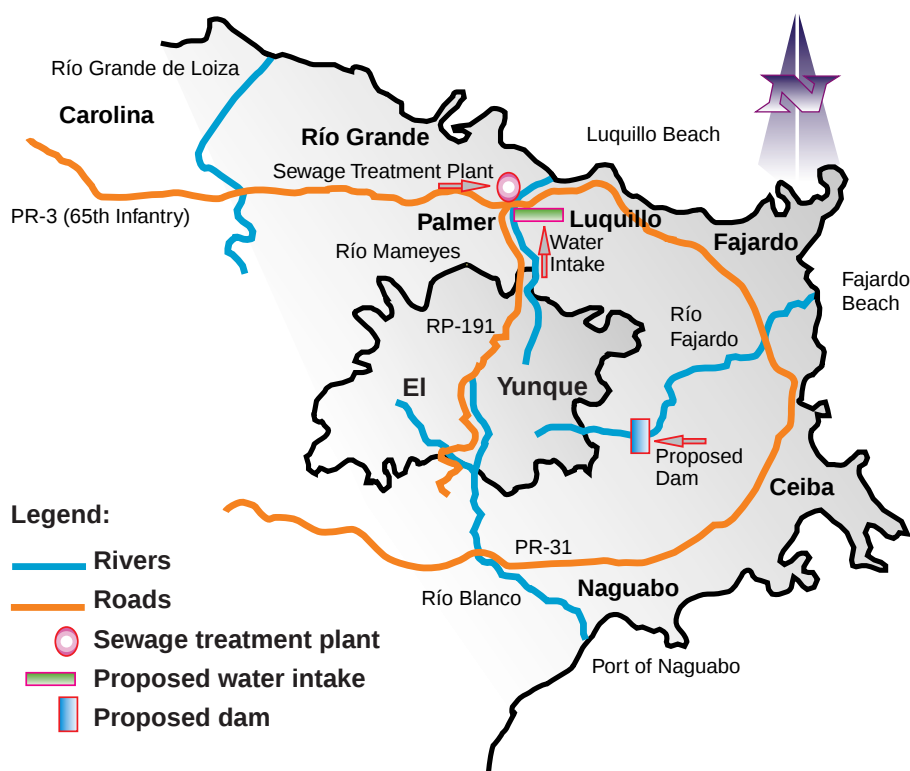


Figure 1 — The Ríos Mameyes and Fajardo and the proposed projects.

Please tell us the importance of this river to you. Using a scale of 1 to 5, 5 being the most important, choose the level that most closely reflects your feelings. Circle only one answer for each of the reasons. Begin with the one marked with an x.

Reasons	Not Important 1	2	3	4	Very Important 5
1. Species Preservations (plants and animals)	[]	[]	[]	[]	[]
2. Natural Beauty	[]	[]	[]	[]	[]
3. Recreation	[]	[]	[]	[]	[]
4. Wildlife	[]	[]	[]	[]	[]
5. Employment for Fishermen	[]	[]	[]	[]	[]
6. Clean Air	[]	[]	[]	[]	[]
7. Cultural	[]	[]	[]	[]	[]
8. Tourism	[]	[]	[]	[]	[]
9. Water Supply	[]	[]	[]	[]	[]
10. Food Source	[]	[]	[]	[]	[]
11. Preserve for the Future	[]	[]	[]	[]	[]
12. Environmental Protection	[]	[]	[]	[]	[]
13. Defines the Rural Area	[]	[]	[]	[]	[]
14. Fish Production	[]	[]	[]	[]	[]
15. Others (Please specify)					
_____	[]	[]	[]	[]	[]
_____	[]	[]	[]	[]	[]
_____	[]	[]	[]	[]	[]

RECREATIONAL USE OF THE RÍO MAMEYES

Q-1 Including yourself, how many people are in your group?

Adults _____ Teen Agers _____ Children _____

Q-2 Now we would like to know how many times in the last 12 months you have visited the Río Mameyes.

Number of times _____

Q-3 In this visit to the river, where did you come from?

Municipality _____ Zip Code 00 _____

Ward/Housing Track _____

Q-3a How long did it take you to get here? Hours _____ Minutes _____

Q-3b What is the approximate distance, in miles, from where you came to this place?

Total miles _____

Q-4 How long are you planning on staying in the river?

All day? (6-8 hours) _____ Half day? (3-5 hours) _____

Hours _____

Q-5 For this visit, the Río Mameyes was:

The principal reason for your visit	1
One of many places that visited today	2
An incidental visit	3

Q-6 During your stay in the river, in what kind of activities would you participate?

Picnic	1	Swimming in the river	4
Photography	2	Commercial Fishing	5
Sun bathe	3	Recreational	6
Others (Please list):	7		

Q-7 During this visit, how much do you think you have spent on food and gasoline? **(Remember that the cost of gasoline is round trip to and from the river.)**

Gas \$_____ Foods \$_____

Some other expenditures that you may have forgotten such as film, sun screen, beach balls, etc.

Other expenditures \$_____

Q-8 The cost of recreation increases as gasoline price goes up. Taking into consideration that there are other rivers and beaches nearby where you can go to recreate, if the cost of this visit to the river was \$X_____ more than what you have already spent, would you have still come today?

Yes 1 **(Go to Q-9)**
No 2 **(Go to Q-10)**

Q-9 If the additional cost was \$Y_____, would you have still come today to the Río Mameyes?

Yes 1 **(Go to Q-9A)**
No 2 **(Go to proposal to modify the Río Mameyes)**

Q-9a Would you really pay that amount for each visit to the Río Mameyes?

Yes 1 **(Go to Q-9B)**
No 2 **(Go to Q-9C)**

Q-9b This amount represents \$_____ per year. **(Compute the total cost involved by multiplying the highest amount reported in Q-9 times the number of times the person said she/he would come to the river in Q-2);** and ask: Would you really pay this yearly amount to visit the Río Mameyes?

Yes 1 **(Go to proposal to modify the Río Mameyes)**
No 2 **(Go to Q-9C)**

Q-9c What is the maximum amount per visit that you would pay to come to the Río Mameyes?

\$_____ **(Go to proposal to modify the Río Mameyes)**

Q-10 If the additional cost for today's visit was \$Z_____, would you still have come to the river today?

Yes 1 **(Go to proposal to modify the Río Mameyes)**
No 2 **(Go to Q-11)**

Q-11 If the additional cost for today's visit was \$1, would you still have come to the river today?

Yes 1 **(Go to proposal to modify the Río Mameyes)**
No 2 **(Go to Q-12)**

Q-12 We would like to know why you would not be willing to pay \$1 additional to visit the Río Mameyes?

The following information describes the Aqueduct and Sewer Agency (AAA) proposal to modify the Río Mameyes. **(Please hand out pages to interviewee and read the material carefully. Emphasize the points with interviewee.)**

PROPOSALS TO MODIFY THE RÍO MAMEYES

Río Mameyes

The Puerto Rico Aqueduct and Sewer Authority (AAA) is considering two proposals for extracting water from the Río Mameyes:

1) Extracting 10 million gallons of water daily (mgd) from the Río Mameyes to supply the present and future needs of the cities of Luquillo, Río Grande, Canovanas, Loiza, San Juan, and the proposed hotel complex close to Río Mar (**show Graph 1 [fig. 2]**).

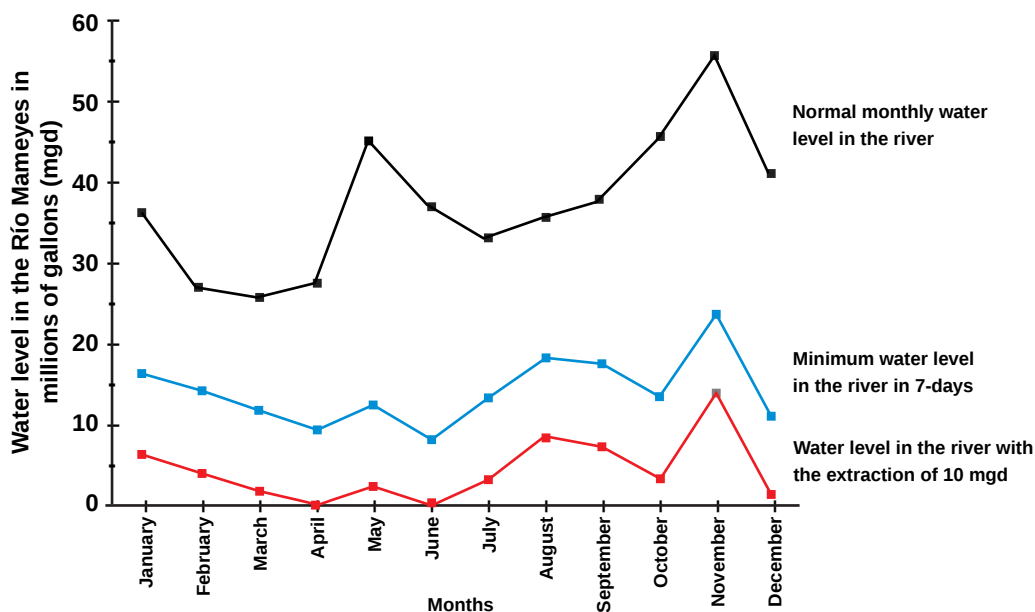


Figure 2—Effect on the water level in the Río Mameyes from the extraction of 10 mgd of water proposed by the AAA (Program 1).

2) Extracting water from the river, but guaranteeing a minimum flow of at least 5 mgd (**show Graph 1A [fig. 3]**).

As you can see on Map 1 (**show Map, fig. 1**), the proposed water intake will be close to Route 3 (65th of Infantry Ave.) in the town of Palmer. Therefore, downstream from the water intake, the river will suffer a reduction in the level of water.

In Graph 1 (**direct them to Graph 1 [fig. 2]**) you can see the remaining level of water in the river after the proposed water extraction by the AAA. The black line represents the normal monthly level of water in the river. The blue line represents the 7-days minimum monthly flow in the river. That is, the minimum amount that can be seen in the river in 7 consecutive days. The red line represents the amount of water that would be left in the river after the 10 mgd water extraction proposed by the AAA. The amount of water in the red line is the difference between the 10 mgd water extraction and the 7-days minimum monthly flow (blue line). As can be seen in Graph 1, during the low water season, the proposal to extract 10 mgd water would (potentially) dry up the river during the months of April and July, and almost dry it up during December (**show them in Graph 1 [fig. 2]**).

In both Graphs 1 and 1A [**figs. 2, 3**] all lines represent the same information, except that in Graph 1A the lowest point of the red line read 5 mgd of water. If this option is selected for implementation, the Río Mameyes should maintain a minimum water flow of 5 mgd (**show Graph 1A [fig. 3]**).

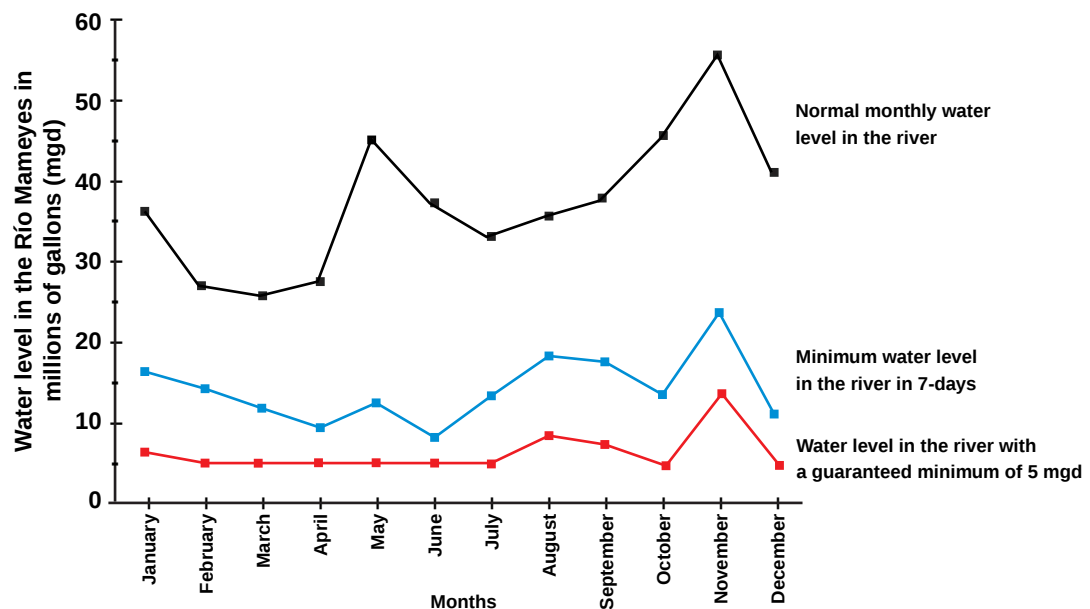


Figure 3—Effect on the water level in the Río Mameyes from the proposed water extraction by the AAA, leaving a minimum level of 5 mgd (Program 1A).

The reduction of water in the river would occur in the same location that the local AAA sewage treatment plant discharges its effluents (**show on Map 1 [fig. 1]**). There is great concern over these discharges because of the increase in the concentration of pollutants in the river and its effect on the river aquatic life. In addition, the Río Mameyes flows into the Atlantic near Luquillo Beach. The contamination of Luquillo Beach could have a significant negative impact on the local economy.

In addition, during those periods in which the river bed is dry or almost dry (**show in Graph 1 [fig. 2]**) the native species of fish and shrimps would not be able to swim upstream to complete their reproductive cycle. The reproductive cycle of the native species of fish and shrimps include maturing in the estuary and then swimming upstream to their spawning grounds where they themselves were born. Therefore, during those months in which the river is dry a significant reduction in the amount of native species in the river would occur. Another reduction in the amount of native species in the river would occur when they are siphoned by the water intake in the river.

Scientists, fishermen and community leaders have expressed grave concern over the possible negative impacts the proposal by AAA to extract 10 mgd of water would have on the local community and the river plant and aquatic communities.

Q-13a In question **Q-2** you said that you have visited the river _____ times during the last 12 months. Given the information on the proposals for the Río Mameyes, please indicate if your visitation to the river would INCREASE, DECREASE, or STAY THE SAME, if the river was affected as shown in Graph 1 (**fig. 2**). Remember that these visits would be in addition to, or reduction to those visits taken already during the year.

(Show them graph 1 emphasizing the relationship between the red and the blue line.)

Graph 1 (fig. 2)

(To extract 10 mgd of water)

Number of visits per year

_____ more [1] How much more? _____

_____ less [-1] How much less? _____

_____ the same [0]

Q-13b In question **Q-2** you said that you have visited the river _____ times during the last 12 months. Given the information on the proposals for Río Mameyes, please indicate if your visitation to the river would INCREASE, DECREASE, or STAY THE SAME, if the river was affected as shown in Graph 1A (**fig. 3**). Remember that these visits would be in addition to, or reduction to those visits taken already during the year.

(Show them Graph 1A emphasizing the relationship between the red and the blue line.)

Graph 1A (fig. 3)

(5 mgd of water)

Number of visits per year

_____ more [1] How much more? _____

_____ less [-1] How much less? _____

_____ the same [0]

Now we want to ask you some questions that help us in classification. (Assure participants that the answers will remain anonymous. Under no circumstances will their name be revealed).

Q-14 Before this interview, how much would you say that you knew, heard, or read about the Río Mameyes?

A lot 1 Little 2 Nothing 3

Q-15 What is your educational level? **(Hand them card)**

1. Grade School 1 2 3 4 5 6

2. Secondary School 7 8 9

3. High School 10 11 12

4. University 13 14 15 16 17 18 19 20 21 22 23

Q-16 Do you belong to an environmental group?

Yes 1 No 2

Q-17 During the last 12 months, have you donated or contributed to wildlife protection or the protection of the environment?

Yes 1 No 2

Q-18 We would like to have an idea of the family annual income. Please tell us in which of the following income categories your family income fall. **(Hand them table).**

1. Less than \$5,000
2. \$5,000 - \$9,999
3. \$10,000 - \$14,999
4. \$15,000 - \$19,999
5. \$20,000 - \$24,999
6. \$25,000 - \$29,999
7. \$30,000 - \$34,999
8. \$35,000 - \$39,999
9. More than \$40,000

Thank you for your participation. Your cooperation will provide the agencies involved with better information on the economic and ecological value the people of Puerto Rico have for these rivers. If you are interested in receiving a copy of the study results, please give me your name and address to send you a copy. We want to assure you again, that your name cannot be associated with the answers to the questionnaire.

Starting time: _____ Date: _____ #Questionnaire: _____

Hello, my name is _____. I work for Hispania Research Corporation and I am doing this survey on behalf of the USDA Forest Service. You have been randomly selected to be interviewed and I request a few minutes of your time to complete the survey. Thanks.

A. Do you work in any of the following agencies? **(Stop interview if answer yes to any.)**

	No	Yes	
Department of Natural Resources	1	2	(Stop)
Fish & Wildlife Service	1	2	(Stop)
Aqueduct and Sewer Authority	1	2	(Stop)
Forest Service	1	2	(Stop)
Planning Board	1	2	(Stop)
Army Corp of Engineers	1	2	(Stop)
Governor's Office	1	2	(Stop)
Environmental Quality Board	1	2	(Stop)

B. May I talk to the head of the household ? **(Check quota)**

Yes **(Go to Q-D)** No **(Stop)**

C. Sex **(By observation, check quota)**

Female: ___ 1 Male: ___ 2

D. Please indicate your age group **(Hand out card)**

Less than 18 years	(Stop)
18 - 24 years	1
25 - 34 years	2
35 - 44 years	3
45 - 54 years	4
55 - 64 years	5
65 - 70 years	6
71 - 75 years	7
76 - 80 years	8
80 +	(Stop)

First, let me give you a short description about the river.

Description of the Río Mameyes

The Río Mameyes headwaters start atop of El Yunque mountain in the Caribbean National Forest. At present it flows uninterrupted for 7.5 miles meandering through the town of Palmer until reaching the Atlantic Ocean as can be seen in Map 1 (**show Map [fig. 1]**). The Río Mameyes is one of the last rivers in Puerto Rico and the Caribbean that flows freely through all existing ecosystems from the rain forest atop the mountains to the coastal plains, wetlands and mangroves. This river has the highest number of species or biodiversity of all rivers in the El Yunque area. These species include several species of native fishes and shrimps.

Some stretches of the Río Mameyes have been designated by the United Nations as Biosphere Reserve. To protect the beauty of this river, the USDA Forest Service, Caribbean National Forest Management Plan have recommended that 3.6 miles of the Río Mameyes be designated as “natural” or “scenic” under the Scenic and Natural Rivers Act of the Federal Government.

Description of the Río Fajardo

The Río Fajardo headwaters spring from the East Peak in the El Yunque mountains and flows for 8 miles through the city of Fajardo before draining into the Atlantic Ocean at the Fajardo Beach (**show Map 1 [fig. 1]**). This is one of the most remote and isolated rivers of all rivers in the El Yunque mountains. The river is very beautiful and has many waterfalls.

The Río Fajardo has one of the largest biodiversity of shrimp and fish species of all rivers in the El Yunque mountains. The USDA Forest Service has recommended that more than half of the river be designated as “natural” under the Scenic and Natural Rivers Act of the Federal government to protect the beauty and special characteristics of the river.

IMPORTANCE OF THE RIVERS

Now, I would like to know more about the importance of the Río Mameyes. People have different reasons to worry about the rivers in Puerto Rico: for some the rivers are important because they provide food or recreation; for others, because they provide them with peace and quiet; and for others, the ecological value of the rivers. And for you, why is this river important?

Please tell us the importance of this river to you. Using a scale of 1 to 5, 5 being the most important, choose the level that most closely reflects your feelings. Circle only one answer for each of the reasons. (Please hand out the importance card and read all the reasons.) Begin with the one marked with an x and read them all.

Reasons	Not Important				Very Important
	1	2	3	4	5
1. Species Preservations (plants and animals)	[]	[]	[]	[]	[]
2. Natural Beauty	[]	[]	[]	[]	[]
3. Recreation	[]	[]	[]	[]	[]
4. Wildlife	[]	[]	[]	[]	[]
5. Employment for Fishermen	[]	[]	[]	[]	[]
6. Clean Air	[]	[]	[]	[]	[]
7. Cultural	[]	[]	[]	[]	[]
8. Tourism	[]	[]	[]	[]	[]
9. Water Supply	[]	[]	[]	[]	[]
10. Food Source	[]	[]	[]	[]	[]
11. Preserve for the Future	[]	[]	[]	[]	[]
12. Environmental Protection	[]	[]	[]	[]	[]
13. Defines the Rural Area	[]	[]	[]	[]	[]
14. Fish Production	[]	[]	[]	[]	[]
15. Others (Please specify)					
_____	[]	[]	[]	[]	[]
_____	[]	[]	[]	[]	[]
_____	[]	[]	[]	[]	[]

The following information describes the Aqueduct and Sewer Agency (AAA) proposal to modify the Río Mameyes. **(Please hand out pages 3 and 4 to interviewee and read the material aloud carefully to interviewee.)**

PROPOSALS TO MODIFY THE RÍO MAMEYES

Río Mameyes

The Puerto Rico Aqueduct and Sewer Authority (AAA) is considering two proposals for extracting water from the Río Mameyes. The first option is to extract 10 million gallons of water daily (mgd) from the Río Mameyes to supply the present and future needs of the cities of Luquillo, Río Grande, Canovanas, Loiza, San Juan, and the proposed hotel complex close to Río Mar (**show Graph 1 [fig. 2]**). The second option is to extract water from the river, but guaranteeing a minimum flow of at least 5 mgd (**show Graph 1A [fig. 3]**). As you can see on Map 1 (**show Map [fig. 1]**), the proposed water intake for both projects will be close to Route 3 (65th of Infantry Ave.) in the town of Palmer. Therefore, downstream from the water intake, the river will suffer a reduction in the flow or level of water.

In Graph 1 (**direct them to Graph 1 [fig. 2]**) you can see the remaining level of water in the river after the proposed water extraction by the AAA. The black line represents the normal monthly level of water in the river. The blue line represents the 7-days minimum monthly flow in the river. That is, the minimum amount that can be seen in the river in 7 consecutive days. The red line represents the amount of water that would be left in the river after the 10 mgd water extraction proposed by the AAA. The amount of water in the red line is the difference between the 10 mgd water extraction and the 7-days minimum monthly flow (blue line). As can be seen in Graph 1, during the low water season, the proposal to extract 10 mgd water would (potentially) dry up the river during the months of April and July, and almost dry it up during December (**show them in Graph 1 [fig. 2]**).

In both Graphs, 1 and 1A (**figs. 2, 3**) all lines represent the same information, except that in Graph 1A the lowest point of the red line read 5 mgd of water. If this option is selected for implementation, the Río Mameyes should maintain a minimum water flow of 5 mgd (**show Graph 1A [fig. 3]**).

The reduction of water in the river would occur in the same location that the local AAA sewage treatment plant discharges its effluents (**show on Map 1 [fig. 1]**). There is great concern over these discharges because the increase in the concentration of pollutants in the river and its effect on the river aquatic life. In addition, the Río Mameyes flows into the Atlantic near Luquillo Beach. The contamination of Luquillo Beach could have a significant negative impact on the local economy.

In addition, during those periods in which the river bed is dry or almost dry (**show in Graph 1 [fig. 2]**) the native species of fish and shrimps would not be able to swim upstream to complete their reproductive cycle. The reproductive cycle of the native species of fish and shrimps include maturing in the estuary and then swimming upstream to their spawning grounds where they themselves were born. Therefore, during those months in which the river is dry a significant reduction in the amount of native species in the river would occur. Another reduction in the amount of native species in the river would occur when they are siphoned by the water intake in the river.

Scientists, fishermen and community leaders have expressed grave concern over the possible negative impacts the proposal by AAA to extract 10 mgd of water would have on the local community and the river plant and aquatic communities.

Río Fajardo

The commonwealth of Puerto Rico and the U.S. Federal Government, through the Army Corps of Engineers, are proposing the construction of a dam in the Río Fajardo. Recent studies from the University of Puerto Rico Mayagüez Campus have shown that dams reduce the number of native species of shrimp and fish in the rivers by blocking their migration route from the river to the ocean and vice versa. During periods of minimum flow in the rivers, dams tend to divert all river flow downstream from the dam further diminishing the native species of shrimp and fishes.

ALTERNATIVE WATER SUPPLY OPTIONS

The AAA have three options for trying to solve the water rationing problem caused by the drought events every 10 to 20 years. These include:

1. Reducing the water losses in the system by repairing the distribution lines and reducing the number of illegal connections to the distribution system.

As can be seen on Graph 2 (**show Graph 2 [fig. 4]**), the AAA cannot account for 197 mgd or 40 percent of the 453 mgd that it produces. Reducing the amount of water unaccounted for from 197 mgd to 82 mgd or 15 percent of the total produced would increase the amount of water available in the system by 115 mgd. The total water available for distribution would increase from 256 to 371 mgd. This amount is 10 times greater than the amount the AAA is proposing to extract from the Mameyes.

2. Maintain the water capacity of the reservoirs by reducing the sedimentation.

There are several lakes and reservoirs in Puerto Rico available to store water, but their storage capacity is greatly reduced by the accumulation of sediments and mud. Implementing measures to reduce or avoid the erosion of soils into the reservoirs and the removal of sediments from the reservoirs would increase the water storage capacity of the lakes and reservoirs.

3. Water conservation measures.

Substitute high water consumption toilets and shower heads with modern low flow toilets and water heads that use much less water. This measure has been implemented in several cities and resulted in significant reductions in the water used per family.

HOW TO PAY FOR THE ALTERNATIVE WATER SUPPLY OPTIONS—RÍO MAMEYES

Any of the three water supply option alternatives would eliminate the need for construction of a water intake in the Río Mameyes and the reduction in the water level in the river that it entails.

However, these three options are very expensive and more money is needed to pay for whichever option is selected. To finance the implementation of a program, all recreationists in Puerto Rico that use the lakes, forest reserve, and developed public beaches would pay an increase in entry and parking fees for using the facilities.

The money collected from this increase in entrance and parking fees will be given to a water conservation trust fund **administered by a water commission independently of the AAA**. This commission would be responsible for implementing a management program to solve the water rationing problems. The members of the water commission **will not** receive any payment for their services by administering the trust fund. A statute will prohibit using the water trust funds for any purposes other than those established in the trust enabling law.

However, even the increase in entrance and parking fees will not be enough to finance the program to repair the distribution lines and provide the families with water-efficient toilets and shower heads to install in their homes. Puerto Rico's households would need to make an additional donation to help solve the problem. The household's donation would be collected through check off in their income tax return in which they would designate how much of their refund would be donated to the water trust fund, or how much additional money they would like to donate to the Water Trust Fund. The Puerto Rico tax return form does not have this check off procedure today, but this type of contribution is already in use in 16 states of the USA, including California, Colorado, and Minnesota.

In the next pages we are going to ask you about how much would you be willing to pay to protect only the Río Mameyes, only the Río Fajardo, and about a program to protect both rivers at the same time.

Before we move on, **we would like to know if you have any questions (answer any questions).**

PROGRAM 1

A water commission independent of the AAA, through a water trust fund, would implement a program to repair the water distribution lines throughout the island, and install 50,000 Puerto Rican homes with water efficient toilets and shower heads.

Taking this situation into consideration, please respond to the following questions.

Q-1 Would you pay \$10.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program 1, which includes repairing the water distribution lines and installing 50,000 Puerto Rican homes with efficient shower heads and toilets that consume less water so that water would not have to be extracted from the Río Mameyes? This program would help increase the water supply and maintain the water quality and level in the Río Mameyes. Furthermore, the program would protect the natural habitat of shrimps, fishes and plants in the river as represented by the blue line on Graph 1 (**show blue line on Graph 1 [fig. 2]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1.

Yes	1	(Go to Q-2A)
No	2	(Go to Q-2B)

Q-2a Would you pay \$20.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program 1? (**show blue line on Graph 1 [fig. 2]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1.

Yes1 (**Go to Program 1A**)
No2 (**Go to Program 1A**)

Q-2b Would you pay \$5.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program 1? (**show blue line on Graph 1 [fig. 2]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1.

Yes1 (**Go to Program 1A**)
No2 (**Go to Q-3**)

Q-3 Would you pay \$1.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program 1? If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1.

Yes1 No2

HOW TO PAY FOR THE WATER SUPPLY ALTERNATIVES—RÍO MAMEYES

(Ask if they need the material in pages 3-4, read to them again, and ask if they have any questions.)

PROGRAM 1A

As can be seen on Graph 1 (fig. 2), if 10 mgd of water are extracted from the river, as proposed by the AAA, during 3 months of the year the Río Mameyes would be dry or almost dry (show on graph). Because of this situation the AAA has a proposal to maintain a minimum level of 5 mgd in the river all year around (show on Graph 1A [fig. 3]). Taking this situation into consideration, please respond to the following questions.

Q-4 Would you pay \$10.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program 1A, which includes repairing the water distribution lines and installing 50,000 Puerto Rican homes with efficient shower heads and toilets that consume less water so that water would not have to be extracted from the Río Mameyes? This program would help increase the water supply and to maintain the water quality and level in the Río Mameyes. Furthermore, the program would protect the natural habitat of shrimps, fishes and plants in the river as represented by the blue line on Graph 1 (**show blue line on Graph 1A [fig. 3]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1.

Yes1 (**Go to Q-5A**)
No2 (**Go to Q-5B**)

Q-5a Would you pay \$20.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program 1A? (**show blue line on Graph 1A [fig. 3]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1.

Yes1 (Go to Program B, Río Fajardo)
 No2 (Go to Program B, Río Fajardo)

Q- 5b Would you pay \$5.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program 1A? (**show blue line on Graph 1A [fig. 3]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1.

Yes1 (Go to Program B, Río Fajardo)
 No2 (Go to Q-3)

Q-6 Would you pay \$1.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program 1A? (**show blue line on Graph 1A [fig. 3]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1a.

Yes1 No2

HOW TO PAY FOR THE WATER SUPPLY ALTERNATIVES — RÍO FAJARDO

Let us present you now with the options available for the construction on the Río Fajardo. Please remember that this alternative is totally independent of the one discussed for the Río Mameyes earlier.

PROGRAM B

Any of the three water supply option alternatives would eliminate the need for construction of a water intake in the Río Mameyes and the reduction in the water level in the river that it entails.

However, these three options are very expensive and more money is needed to pay for whichever option is selected. To finance the implementation of a program, all recreationists in Puerto Rico that use the lakes, forest reserve, and developed public beaches would pay an increase in entry and parking fees for using the facilities.

The money collected from this increase in entrance and parking fees will be given to a water conservation trust fund **administered by a water commission independently of the AAA**. This commission would be responsible for implementing a management program to solve the water rationing problems. The members of the water commission **will not** receive any payment for their services by administering the trust fund. A statute will prohibit using the water trust funds for any purposes other than those established in the trust enabling law.

However, even the increase in entrance and parking fees will not be enough to finance the program to repair the distribution lines and provide the families with water-efficient toilets and shower heads to install in their homes. Puerto Rico's households would need to make an additional donation to help solve the problem. The household's donation would be collected through check off in their income tax return in which they would designate how much of their refund would be donated to the water trust fund, or how much additional money they would like to donate to the Water Trust Fund. The Puerto Rico tax return form does not have this check off procedure today, but this type of contribution is already in use in 16 states of the USA, including California, Colorado, and Minnesota.

Before we move on, **we would like to know if you have any questions (answer any questions).**

Taking this situation into consideration, please respond to the following questions.

Q-7. Would you pay \$10.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing **Program B**, which includes repairing the water distribution lines and dredging of the Carraizo and La Plata reservoirs to increase their storage capacity by the same volume proposed for the dam on the Río Fajardo, and thus, not having to build the dam on the river?

Yes1 **(Go to Q-8A)**
 No2 **(Go to Q-8B)**

Q-8a Would you pay \$20.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program B and thus, not having to build the dam on the Río Fajardo?.

Yes1 **(Go to Combined Program)**
 No2 **(Go to Combined Program)**

Q-8b Would you pay \$5.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program B and thus, not having to build the dam on the Río Fajardo?

Yes1 **(Go to Combined Program)**
 No2 **(Go to Q-9)**

Q-9 Would you pay \$1.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program B and thus, not having to build the dam on the river?

Yes1 No2

COMBINED PROGRAM TO PROTECT THE RÍOS MAMEYES AND FAJARDO

The proposals to extract water from the Río Mameyes and to build a dam on the Río Fajardo has been proposed simultaneously. As indicated, though, implementing the programs presented below would provide water to Puerto Rico residents for the next 30 years without the need for any of the two projects proposed.

1. Repair the distribution lines and reduce the number of illegal connections to the distribution lines.
2. Increase the storage capacity of the reservoirs by dredging out mud and sediment.
3. Install in 100,000 homes water efficient toilets and shower heads that use less water.

Any of the three water supply option alternatives would eliminate the need for construction of a water intake in the Río Mameyes and the reduction in the water level in the river that it entails.

However, these three options are very expensive and more money is needed to pay for whichever option is selected. To finance the implementation of a program, all recreationists in Puerto Rico that use the lakes, forest reserve, and developed public beaches would pay an increase in entry and parking fees for using the facilities.

The money collected from this increase in entrance and parking fees will be given to a water conservation trust fund **administered by a water commission independently of the AAA**. This commission would be responsible for implementing a management program to solve the water rationing problems. The members of the water commission **will not** receive any payment for their services by administering the trust fund. A statute will prohibit using the water trust funds for any purposes other than those established in the trust enabling law.

However, even the increase in entrance and parking fees will not be enough to finance the program to repair the distribution lines, dredging of the reservoirs, and to install in 100,000 homes water efficient toilets and shower heads that use less water. Puerto Rico's households would need to make an additional donation to help solve the problem.

Before we move on, **we would like to know if you have any questions (answer any questions).**

PROGRAM C

A water commission independent of the AAA, through a water trust fund, would implement a program which includes repairing the water distribution lines throughout the island, dredging the Carraizo and La Plata Reservoirs, and installing 100,000 Puerto Rican homes with water efficient toilets and shower heads.

Taking this situation into consideration, please respond to the following questions.

Q-10 Would you pay \$15.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program C, which includes repairing the water distribution lines, dredging the Carraizo and La Plata reservoirs, and installing 100,000 Puerto Rican homes with efficient shower heads and toilets that consume less water so that water would not have to be extracted from the Río Mameyes, nor a dam built on the Río Fajardo?

(show blue line on Graph 1 [fig. 2]). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1 and the dam will be built on the Río Fajardo.

Yes	1	(Go to Q-11A)
No	2	(Go to Q-11B)

Q-11a Would you pay \$25.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program C? **(show blue line on Graph 1 [fig. 2]).** If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1 and the dam will be built on the Río Fajardo

Yes	1	(Go to Q-13)
No	2	(Go to Q-13)

Q-11b Would you pay \$5.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program C? (**show blue line on Graph 1 [fig. 2]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1 and the dam will be built on the Río Fajardo.

Yes1 (Go to Q-13)
No2 (Go to Q-12)

Q-12 Would you pay \$1.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program C? If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1 (**fig. 2**) and the dam will be built on the Río Fajardo.

Yes1 No2

In the next section we ask some questions to determine the reasons why the respondents would or would not pay for the programs presented to them. Let participants answer freely and try to classify them according to the categories listed in questions 13 and 14.

If participants answered questions Q-3, Q-6, Q-9, and Q-12, they should be asked Q-13.

If the participant didn't answer any of the questions Q-3, Q-6, Q-9, OR Q-12, they should be asked Q-14.

If the participant didn't answer some of the questions Q-3, Q-6, Q-9, AND Q-12, they must be asked both questions Q-13 and Q-14.

Q-13 Please let us now which is the principal reason for which you would or would not pay \$1.00 only to implement the programs described here? (**Only one reason**)

This program doesn't have any value for me.....	01
My economic situation doesn't allow me to pay anything now.....	02
Don't believe that the program would work.....	03
It's not fair that I pay for this program.....	04
I oppose any new government program.....	05
The AAA should pay for the program.....	06
Any other reason (Please specify).....	07

Doesn't know.....	98
Refuse to participate.....	99

Q-14 Which is the principal reason why you would pay for these programs? **(Only one reason)**

This program has at least this much value to me..... 01

It is my duty to protect these rivers in its natural conditions

and also the flora and fauna of the area..... 02

To contribute to a good cause..... 03

To pay my fair share for the protection of these rivers..... 04

Any other reason **(Please specify)**..... 05

Doesn't know..... 98

Refuse to answer..... 99

YOUR RECREATIONAL USE OF THE RÍOS MAMEYES AND FAJARDO

Q-15 Before this interview, how much would you say you knew about the Río Mameyes?

A lot..... 1 Some..... 2 Nothing..... 3

Q-16 Before this interview, how much would you say you knew about the Río Fajardo?

A lot..... 1 Some..... 2 Nothing..... 3

Q-17 Now, please tell us how many times during the last 12 months have you visited the Ríos Mameyes and Fajardo?

Río Mameyes: # _____ Río Fajardo: # _____

Q-18 For each of the rivers that you have visited tell us if you would visit them MORE, LESS, or THE SAME if the river were affected as described below (evaluate the rivers discussed in Q-17) **(Show them Graphs 1 and 1A [figs. 2,3], highlighting the red line on both graphs to evaluate the Río Mameyes.)**

Q-18a (show Graph 1 [fig. 2]) If 10 mgd of water were extracted from the Río Mameyes, would you visit it...

More.....1 Less.....2 The Same.....3

Q-18b (show Graph 1A [fig. 3]) If a minimum of 5 mgd of water were left in the Río Mameyes, would you visit it...

More.....1 Less.....2 The Same.....3

Q-18c If the proposed dam is built on Río Fajardo, would you visit it...

More.....1 Less.....2 The Same.....3

Q-19 Have you gone fishing during the last 12 months?

Yes.....1 No.....2

Now we want to ask you some questions that help us in the classification. **(Assure participants that the answers will remain anonymous. Under no circumstances will their name be revealed).**

Q-20 What is your educational level? **(Hand them card)**

1. Grade School 1 2 3 4 5 6
2. Secondary School 7 8 9
3. High School 10 11 12
4. University 13 14 15 16 17 18 19 20 21 22 23

Q-21 How many people live in this home including yourself?

- 1 2 3 4 5 6 or more

Q-22 Do you belong to an environmental group?

- Yes 1 No 2

Q23 During the last 12 months, have you donated or contributed to wildlife protection or the protection of the environment?

- Yes 1 No 2

Q-24 What is your Zip Code? _____

Q-25 We would like to have an idea of the family annual income. Please tell us in which of the following income categories your family income falls. **(Hand them table)**

1. Less than \$5,000
2. \$5,000 - \$9,999
3. \$10,000 - \$14,999
4. \$15,000 - \$19,999
5. \$20,000 - \$24,999
6. \$25,000 - \$29,999
7. \$30,000 - \$34,999
8. \$35,000 - \$39,999
9. More than \$40,000

Q-26 Region:

Greater San Juan	1	Mayagüez	4
San Juan Sub Region	2	Arecibo	5
Ponce	3		

Q-27 Questionnaire Type C1-5

Thank you for your participation. Your cooperation will provide the agencies involved with better information on the economic and ecological value the people of Puerto Rico have for these rivers. If you are interested in receiving a copy of the study results, please give me your name and address to send you a copy. We want to assure you again, that your name cannot be associated with the answers to the questionnaire.

Yes.....1

No.....2

If your postal address is different from your residential address, please write it for us below if you would like to receive a copy of the findings of this study.

Name: _____

Address: _____

Starting time: _____ Date: _____ #Questionnaire: _____

Hello, my name is _____. I work for Hispania Research Corporation and I am doing this survey on behalf of the USDA Forest Service. You have been randomly selected to be interviewed and I request a few minutes of your time to complete the survey. Thanks.

A. Do you work in any of the following agencies? **(Stop interview if answer yes to any.)**

	No	Yes	
Department of Natural Resources	1	2	(Stop)
Fish & Wildlife Service	1	2	(Stop)
Aqueduct and Sewer Authority	1	2	(Stop)
Forest Service	1	2	(Stop)
Planning Board	1	2	(Stop)
Army Corp of Engineers	1	2	(Stop)
Governor's Office	1	2	(Stop)
Environmental Quality Board	1	2	(Stop)

B. May I talk to the head of the household ? **(Check quota)**

Yes **(Go to Q-D)** No **(Stop)**

C. Sex **(By observation, check quota)**

Female: _____ 1 Male: _____ 2

D. Please indicate your age group **(Hand out card)**

Less than 18 years	(Stop)
18 - 24 years	1
25 - 34 years	2
35 - 44 years	3
45 - 54 years	4
55 - 64 years	5
65 - 70 years	6
71 - 75 years	7
76 - 80 years	8
80 +	(Stop)

First, let me give you a short description about the river.

Description of the Río Mameyes

The Río Mameyes headwaters start atop of El Yunque mountain in the Caribbean National Forest. At present it flows uninterrupted for 7.5 miles meandering through the town of Palmer until reaching the Atlantic Ocean as can be seen in Map 1 (**show Map [fig. 1]**). The Río Mameyes is one of the last rivers in Puerto Rico and the Caribbean that flows freely through all existing ecosystems from the rain forest atop the mountains to the coastal plains, wetlands and mangroves. This river has the highest number of species or biodiversity of all rivers in the El Yunque area. These species include several species of native fishes and shrimps.

Some stretches of the Río Mameyes have been designated by the United Nations as Biosphere Reserve. To protect the beauty of this river, the USDA Forest Service, Caribbean National Forest Management Plan has recommended that 3.6 miles of the Río Mameyes be designated as “natural” or “scenic” under the Scenic and Natural Rivers Act of the Federal Government.

Description of the Río Fajardo

The Río Fajardo headwaters spring from the East Peak in the El Yunque mountains and flows for 8 miles through the city of Fajardo before draining into the Atlantic Ocean at the Fajardo Beach (**show Map 1 [fig. 1]**). This is one of the most remote and isolated rivers of all rivers in the El Yunque mountains. The river is very beautiful and has many waterfalls.

The Río Fajardo has one of the largest biodiversity of shrimp and fish species of all rivers the El Yunque mountains. The USDA Forest Service has recommended that more than half of the river be designated as “natural” under the Scenic and Natural Rivers Act of the Federal government to protect the beauty and special characteristics of the river.

IMPORTANCE OF THE RIVERS

Now, I would like to know more about the importance of the Río Mameyes. People have different reasons to worry about the rivers in Puerto Rico. For some the rivers are important because they provide food or recreation; for others, because they provide them with peace and quiet; and for others, the ecological value of the rivers. And for you, why is this river important?

Please tell us the importance of this river to you. Using a scale of 1 to 5, 5 being the most important, choose the level that most closely reflects your feelings. Circle only one answer for each of the reasons. (Please hand out the importance card and read all the reasons.) Begin with the one marked with an x and read them all.

Reasons	Not Important				Very Important
	1	2	3	4	5
1. Species Preservations (plants and animals)	[]	[]	[]	[]	[]
2. Natural Beauty	[]	[]	[]	[]	[]
3. Recreation	[]	[]	[]	[]	[]
4. Wildlife	[]	[]	[]	[]	[]
5. Employment for Fishermen	[]	[]	[]	[]	[]
6. Clean Air	[]	[]	[]	[]	[]
7. Cultural	[]	[]	[]	[]	[]
8. Tourism	[]	[]	[]	[]	[]
9. Water Supply	[]	[]	[]	[]	[]
10. Food Source	[]	[]	[]	[]	[]
11. Preserve for the Future	[]	[]	[]	[]	[]
12. Environmental Protection	[]	[]	[]	[]	[]
13. Defines the Rural Area	[]	[]	[]	[]	[]
14. Fish Production	[]	[]	[]	[]	[]
15. Others (Please specify)					
_____	[]	[]	[]	[]	[]
_____	[]	[]	[]	[]	[]
_____	[]	[]	[]	[]	[]

The following information describes the Aqueduct and Sewer Agency (AAA) proposal to modify the Río Mameyes. **(Please hand out pages 3 and 4 to interviewee and read the material aloud carefully to interviewee).**

PROPOSALS TO MODIFY THE RÍO MAMEYES

Río Mameyes

The Puerto Rico Aqueduct and Sewer Authority (AAA) is considering two proposals for extracting water from the Río Mameyes. The first option is to extract 10 million gallons of water daily (mgd) from the Río Mameyes to supply the present and future needs of the cities of Luquillo, Río Grande, Canovanas, Loiza, San Juan, and the proposed hotel complex close to Río Mar (**show Graph 1 [fig. 2]**). The second option is to extract water from the river, but guaranteeing a minimum flow of at least 5 mgd (**show Graph 1A [fig. 3]**). As you can see on Map 1 (**show map [fig. 1]**), the proposed water intake for both projects will be close to Route 3 (65th of Infantry Ave.) in the town of Palmer. Therefore, downstream from the water intake, the river will suffer a reduction in the flow or level of water.

In Graph 1 (**direct them to Graph 1 [fig. 2]**) you can see the remaining level of water in the river after the proposed water extraction by the AAA. The black line represents the normal monthly level of water in the river. The blue line represents the 7-days minimum monthly flow in the river. That is, the minimum amount that can be seen in the river in 7 consecutive days. The red line represents the amount of water that would be left in the river after the 10 mgd water extraction proposed by the AAA. The amount of water in the red line is the difference between the 10 mgd water extraction and the 7-days minimum monthly flow (blue line). As can be seen in Graph 1, during the low water season, the proposal to extract 10 mgd water would (potentially) dry up the river during the months of April and July, and almost dry it up during December (**show them in Graph 1 [fig. 2]**).

In both Graphs 1 and 1A [**figs. 2, 3**], all lines represent the same information, except that in Graph 1A the lowest point of the red line read 5 mgd of water. If this option is selected for implementation, the Río Mameyes should maintain a minimum water flow of 5 mgd (**show Graph 1A [fig. 3]**).

The reduction of water in the river would occur in the same location that the local AAA sewage treatment plant discharges its effluents (**show on Map 1 [fig. 1]**). There is great concern over these discharges because the increase in the concentration of pollutants in the river and its effect on the river aquatic life. In addition, the Río Mameyes flows into the Atlantic near Luquillo Beach. The contamination of Luquillo Beach could have a significant negative impact on the local economy.

In addition, during those periods in which the river bed is dry or almost dry (**show in Graph 1 [fig. 2]**) the native species of fish and shrimps would not be able to swim upstream to complete their reproductive cycle. The reproductive cycle of the native species of fish and shrimps include maturing in the estuary and then swimming upstream to their spawning grounds where they themselves were born. Therefore, during those months in which the river is dry a significant reduction in the amount of native species in the river would occur. Another reduction in the amount of native species in the river would occur when they are siphoned by the water intake in the river.

Scientists, fishermen and community leaders have expressed grave concern over the possible negative impacts the proposal by AAA to extract 10 mgd of water would have on the local community and the river plant and aquatic communities.

Río Fajardo

The commonwealth of Puerto Rico and the U.S. Federal Government, through the Army Corps of Engineers, are proposing the construction of a dam in the Río Fajardo. Recent studies from the University of Puerto Rico Mayagüez Campus have shown that dams reduce the number of native species of shrimp and fish in the rivers by blocking their migration route from the river to the ocean and vice versa. During periods of minimum flow in the rivers, dams tend to divert all river flow downstream from the dam further diminishing the native species of shrimp and fishes.

ALTERNATIVE WATER SUPPLY OPTIONS

The AAA have three options for trying to solve the water rationing problem caused by the drought events every 10 to 20 years. These include:

1. Reducing the water losses in the system by repairing the distribution lines and reducing the number of illegal connections to the distribution system.

As can be seen on Graph 2 (**show Graph 2 [fig. 4]**), the AAA cannot account for 197 mgd or 40 percent of the 453 mgd that it produces. Reducing the amount of water unaccounted for from 197 mgd to 82 mgd or 15 percent of the total produced would increase the amount of water available in the system by 115 mgd. The total water available for distribution would increase from 256 to 371 mgd. This amount is 10 times greater than the amount the AAA is proposing to extract from the Río Mameyes.

2. Maintain the water capacity of the reservoirs by reducing the sedimentation.

There are several lakes and reservoirs in Puerto Rico available to store water, but their storage capacity is greatly reduced by the accumulation of sediments and mud. Implementing measures to reduce or avoid the erosion of soils into the reservoirs and the removal of sediments from the reservoirs would increase the water storage capacity of the lakes and reservoirs.

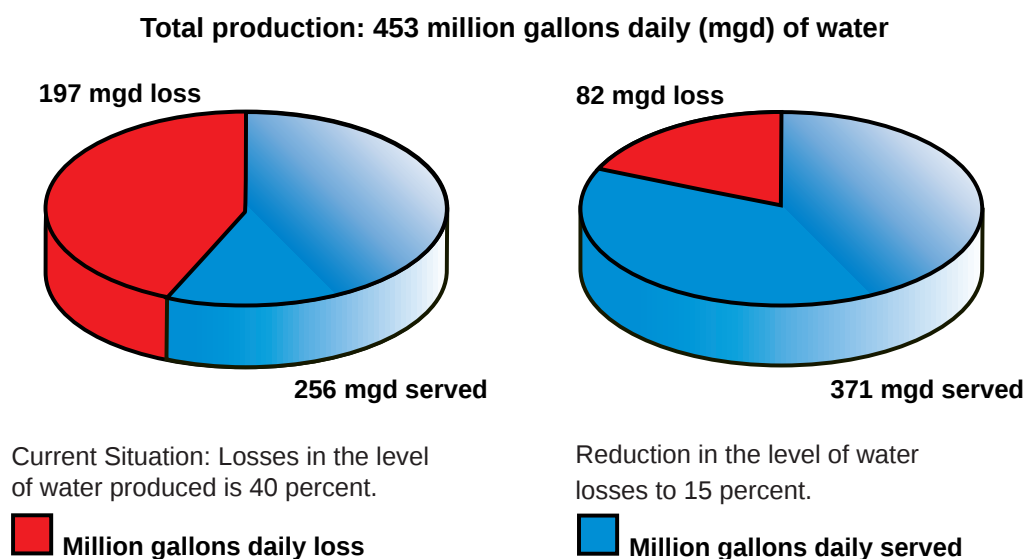


Figure 4—Distribution of the water produced by the AAA.

3. Water conservation measures.

Substitute high water consumption toilets and shower heads with modern low flow toilets and water heads that use much less water. This measure has been implemented in several cities and resulted in significant reductions in the water used per family.

HOW TO PAY FOR THE ALTERNATIVE WATER SUPPLY OPTIONS—RÍO MAMEYES

Any of the three water supply option alternatives would eliminate the need for construction of a water intake in the Río Mameyes and the reduction in the water level in the river that it entails.

However, these three options are very expensive and more money is needed to pay for whichever option is selected. To finance the implementation of a program, all recreationists in Puerto Rico that use the lakes, forest reserve, and developed public beaches would pay an increase in entry and parking fees for using the facilities.

The money collected from this increase in entrance and parking fees will be given to a water conservation trust fund **administered by a water commission independently of the AAA**. This commission would be responsible for implementing a management program to solve the water rationing problems. The members of the water commission **will not** receive any payment for their services by administering the trust fund. A statute will prohibit using the water trust funds for any purposes other than those established in the trust enabling law.

However, even the increase in entrance and parking fees will not be enough to finance the program to repair the distribution lines and provide the families with water-efficient toilets and shower heads to install in their homes. Puerto Rico's households would need to make an additional donation to help solve the problem. The household's donation would be collected through check off in their income tax return in which they would designate how much of their refund would be donated to the water trust fund, or how much additional money they would like to donate to the Water Trust Fund. The Puerto Rico tax return form does not have this check off procedure today, but this type of contribution is already in use in 16 states of the USA, including California, Colorado, and Minnesota.

In the next pages we are going to ask you about how much would you be willing to pay to protect only the Río Mameyes, only the Río Fajardo, and about a program to protect both rivers at the same time.

Before we move on, **we would like to know if you have any questions (answer any questions).**

PROGRAM 1

A water commission independent of the AAA, through a water trust fund, would implement a program to repair the water distribution lines throughout the island, and install 50,000 Puerto Rican homes with water efficient toilets and shower heads.

Taking this situation into consideration, and recognizing the need for solving other environmental problems in Puerto Rico, such as solid waste management, destruction of mangroves, and to save endangered species and to satisfy your family needs, please respond to the following questions.

Q-1. Would you pay \$10.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program 1, which includes repairing the water distribution lines and installing 50,000 Puerto Rican homes with efficient shower heads and toilets that consume less water so that water would not have to be extracted from the Río Mameyes? This program would help increase the water supply and to maintain the water quality and level in the Río Mameyes. Furthermore, the program would protect the natural habitat of shrimps, fishes and plants in the river as represented by the blue line on Graph 1 (**show blue line on Graph 1 [fig. 2]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1.

Yes	1	(Go to Q-2A)
No	2	(Go to Q-2B)

Q-2a Would you pay \$20.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program 1? (**show blue line on Graph 1 [fig. 2]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1.

Yes1 (Go to Program 1A)
No2 (Go to Program 1A)

Q-2b Would you pay \$5.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program 1? (**show blue line on Graph 1 [fig. 2]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1.

Yes1 (Go to Program 1A)
No2 (Go to Q-3)

Q-3 Would you pay \$1.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program 1? If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1.

Yes1 No2

HOW TO PAY FOR THE WATER SUPPLY ALTERNATIVES—RÍO MAMEYES

(Ask if they need the material in pages 3-4, read to them again, and ask if they have any questions).

PROGRAM 1A

As can be seen on Graph 1, if 10 mgd of water are extracted from the river, as proposed by the AAA, during three months of the year the Río Mameyes would be dry or almost dry (**show on graph**). Because of this situation the AAA has a proposal to maintain a minimum level of 5 mgd in the river all year around (**show on Graph 1A [fig. 3]**). Taking this situation into consideration, and recognizing the need for solving other environmental problems in Puerto Rico such as solid waste management, destruction of mangroves, and to save endangered species and to satisfy your family needs, please respond to the following questions.

Q-4. Would you pay \$10.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program 1A, which includes repairing the water distribution lines and installing 50,000 Puerto Rican homes with efficient shower heads and toilets that consume less water so that water would not have to be extracted from the Río Mameyes? This program would help increase the water supply and maintain the water quality and level in the Río Mameyes. Furthermore, the program would protect the natural habitat of shrimps, fishes and plants in the river as represented by the blue line on Graph 1 (**show blue line on Graph 1A [fig. 3]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1.

Yes1 (Go to Q-5A)
No2 (Go to Q-5B)

Q-5a Would you pay \$20.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program 1A? (**show blue line on Graph 1A [fig. 3]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1.

Yes1 (Go to Program B, the Río Fajardo)
 No2 (Go to Program B, the Río Fajardo)

Q- 5b Would you pay \$5.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program 1A? (**show blue line on Graph 1A [fig. 3]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1.

Yes1 (Go to Program B, the Río Fajardo)
 No2 (Go to Q-3)

Q-6 Would you pay \$1.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program 1A? (**show blue line on Graph 1A [fig. 3]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1a.

Yes1 No2

HOW TO PAY FOR THE WATER SUPPLY ALTERNATIVES—RÍO FAJARDO

Let us present you now with the options available for the construction on the Río Fajardo. Please remember that this alternative is totally independent of the one discussed for the Río Mameyes discussed earlier.

PROGRAM B

Any of the three water supply option alternatives would eliminate the need for construction of a water intake in the Río Mameyes and the reduction in the water level in the river that it entails.

However, these three options are very expensive and more money is needed to pay for whichever option is selected. To finance the implementation of a program, all recreationists in Puerto Rico that use the lakes, forest reserve, and developed public beaches would pay an increase in entry and parking fees for using the facilities.

The money collected from this increase in entrance and parking fees will be given to a water conservation trust fund **administered by a water commission independently of the AAA**. This commission would be responsible for implementing a management program to solve the water rationing problems. The members of the water commission **will not** receive any payment for their services by administering the trust fund. A statute will prohibit using the water trust funds for any purposes other than those established in the trust enabling law.

However, even the increase in entrance and parking fees will not be enough to finance the program to repair the distribution lines and provide the families with water-efficient toilets and shower heads to install in their homes. Puerto Rico's households would need to make an additional donation to help solve the problem. The household's donation would be collected through check off in their income tax return in which they would designate how much of their refund would be donated to the water trust fund, or how much additional money they would like to donate to the Water Trust Fund. The Puerto Rico tax return form does not have this check off procedure today, but this type of contribution is already in use in 16 states of the USA, including California, Colorado, and Minnesota.

Before we move on, **we would like to know if you have any questions (answer any questions).**

Taking this situation into consideration, and recognizing the need for solving other environmental problems in Puerto Rico such as solid waste management, destruction of mangroves, and to save endangered species; in addition to satisfying your family needs, please respond to the following questions.

Q-7. Would you pay \$10.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing **Program B**, which includes repairing the water distribution lines and dredging of the Carraizo and La Plata reservoirs to increase their storage capacity by the same volume proposed for the dam on the Río Fajardo, and thus, not having to build the dam on the river?

Yes1 **(Go to Q-8A)**
 No2 **(Go to Q-8B)**

Q-8a Would you pay \$20.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program B and thus, not having to build the dam on the Río Fajardo?

Yes1 **(Go to Combined Program)**
 No2 **(Go to Combined Program)**

Q-8b Would you pay \$5.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program B and thus, not having to build the dam on the Río Fajardo?

Yes1 **(Go to Combined Program)**
 No2 **(Go to Q-9)**

Q-9 Would you pay \$1.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program B and thus, not having to build the dam on the river?

Yes1 No2

COMBINED PROGRAM TO PROTECT THE RÍOS MAMEYES AND FAJARDO

The proposals to extract water from the Río Mameyes and to build a dam on the Río Fajardo has been proposed simultaneously. As indicated, though, implementing the programs presented below would provide water to Puerto Rico residents for the next 30 years without the need for any of the two projects proposed.

1. Repair the distribution lines and reduce the number of illegal connections to the distribution lines.
2. Increase the storage capacity of the reservoirs by dredging out mud and sediment.
3. Install in 100,000 homes water efficient toilets and shower heads that use less water.

Any of the three water supply option alternatives would eliminate the need for construction of a water intake in the Río Mameyes and the reduction in the water level in the river that it entails.

However, these three options are very expensive and more money is needed to pay for whichever option is selected. To finance the implementation of a program, all recreationists in Puerto Rico that use the lakes, forest reserve, and developed public beaches would pay an increase in entry and parking fees for using the facilities.

The money collected from this increase in entrance and parking fees will be given to a water conservation trust fund **administered by a water commission independently of the AAA**. This commission would be responsible for implementing a management program to solve the water rationing problems. The members of the water commission **will not** receive any payment for their services by administering the trust fund. A statute will prohibit using the water trust funds for any purposes other than those established in the trust enabling law.

However, even the increase in entrance and parking fees will not be enough to finance the program to repair the distribution lines, dredging of the reservoirs, and to install in 100,000 homes water efficient toilets and shower heads that use less water. Puerto Rico's households would need to make an additional donation to help solve the problem.

Before we move on, **we would like to know if you have any questions (answer any questions).**

PROGRAM C

A water commission independent of the AAA, through a water trust fund, would implement a program which includes repairing the water distribution lines throughout the island, dredging the Carraizo and La Plata Reservoirs, and installing 100,000 Puerto Rican homes with water efficient toilets and shower heads.

Taking this situation into consideration, and recognizing the need for solving other environmental problems in Puerto Rico such as solid waste management, destruction of mangroves, and to save endangered species and to satisfy your family needs, please respond to the following questions.

Q-10. Would you pay \$15.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program C, which includes repairing the water distribution lines, dredging the Carraizo and La Plata reservoirs, and installing 100,000 Puerto Rican homes with efficient shower heads and toilets that consume less water so that water would not have to be extracted from the Río Mameyes, nor a dam built on the Río Fajardo? (**show blue line on Graph 1 [fig. 2]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1 and the dam will be built on the Río Fajardo.

Yes	1	(Go to Q-11A)
No	2	(Go to Q-11B)

Q-11a Would you pay \$25.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program C? (**show blue line on Graph 1 [fig. 2]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1 and the dam will be built on the Río Fajardo

Yes1 (Go to Q-13)
 No2 (Go to Q-13)

Q-11b Would you pay \$5.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program C? (**show blue line on Graph 1 [fig. 2]**). If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1 and the dam will be built on the Río Fajardo

Yes1 (Go to Q-13)
 No2 (Go to Q-12)

Q-12 Would you pay \$1.00 more a year for the next 5 years to the Water Conservation Trust Fund for implementing Program C? If you do not pay for this program, the level of water in the river is represented by the red line on Graph 1 and the dam will be built on the Río Fajardo

Yes1 No2

In the next section we ask some questions to determine the reasons why the respondents would or would not pay for the programs presented to them. Let participants answer freely and try to classify them according to the categories listed in questions 13 and 14.

If participants answered questions Q-3, Q-6, Q-9, and Q-12, they should be asked Q-13.

If the participant didn't answer any of the questions Q-3, Q-6, Q-9, or Q-12, they should be asked Q-14.

If the participant didn't answer some of the questions Q-3, Q-6, Q-9, and Q-12, they must be asked both questions Q-13 and Q-14.

Q-13 Please let us now which is the principal reason for which you would or would not pay \$1.00 only to implement the programs described here? (**Only one reason**)

This program doesn't have any value for me..... 01
 My economic situation doesn't allow me to pay anything now..... 02
 Don't believe that the program would work..... 03
 It's not fair that I pay for this program..... 04
 I oppose any new government program..... 05
 The AAA should pay for the program..... 06
 Any other reason (**Please specify**)..... 07

Doesn't know..... 98
 Refuse to participate..... 99

Q-14 Which is the principal reason why you would pay for these programs? (**Only one reason**)

This program has at least this much value to me..... 01
 It is my duty to protect these rivers in its natural conditions
 and also the flora and fauna of the area..... 02
 To contribute to a good cause..... 03
 To pay my fair share for the protection of these rivers..... 04
 Any other reason (**Please specify**)..... 05

Doesn't know..... 98
 Refuse to answer..... 99

YOUR RECREATIONAL USE OF THE RÍOS MAMEYES AND FAJARDO**Q-15** Before this interview, how much would you say you knew about the Río Mameyes?

A lot.....1 Some.....2 Nothing.....3

Q-16 Before this interview, how much would you say you knew about the Río Fajardo?

A lot.....1 Some.....2 Nothing.....3

Q-17 Now, please tell us how many times during the last 12 months have you visited the Ríos Mameyes and Fajardo?

Río Mameyes: # _____ Río Fajardo: # _____

(If the answer is zero to both rivers go to Q-19)

Q-18 For each of the rivers that you have visited tell us if you would visit them MORE, LESS, or THE SAME if the river were affected as described below (**evaluate the rivers discussed in Q-17**) (**show them Graphs 1 and 1A (ffigs. 2, 3)**), **highlighting the red line on both graphs to evaluate the Río Mameyes**).**Q-18a (show Graph 1)** If 10 mgd of water were extracted from the Río Mameyes, would you visit it...

More.....1 Less.....2 The Same.....3

Q-18b (show Graph 1A) If a minimum of 5 mgd of water were left in the Río Mameyes, would you visit it...

More.....1 Less.....2 The Same.....3

Q-18c If the proposed dam is built on the Río Fajardo, would you visit it...

More.....1 Less.....2 The Same.....3

Q-19 Have you gone fishing during the last 12 months?

Yes.....1

No.....2

Now we want to ask you some questions that help us in the classification. (Assure participants that the answers will remain anonymous. Under no circumstances will their name be revealed.)

Q-20 What is your educational level? **(Hand them card)**

1. Grade School 1 2 3 4 5 6

2. Secondary School 7 8 9

3. High School 10 11 12

4. University 13 14 15 16 17 18 19 20 21 22 23

Q-21 How many people live in this home including yourself?

1 2 3 4 5 6 or more

Q-22 Do you belong to an environmental group?

Yes 1 No 2

Q23 During the last 12 months, have you donated or contributed to wildlife protection or the protection of the environment?

Yes 1 No 2

Q-24 What is your Zip Code? _____

Q-25 We would like to have an idea of the family annual income. Please tell us in which of the following income categories your family income falls. **(Hand them table)**

1. Less than \$5,000
2. \$5,000 - \$9,999
3. \$10,000 - \$14,999
4. \$15,000 - \$19,999
5. \$20,000 - \$24,999
6. \$25,000 - \$29,999
7. \$30,000 - \$34,999
8. \$35,000 - \$39,999
9. More than \$40,000

Q-26 Region:

Greater San Juan	1	Mayagüez	4
San Juan Sub Region	2	Arecibo	5
Ponce	3		

Q-27 Questionnaire Type C1-5

Thank you for your participation. Your cooperation will provide the agencies involved with better information on the economic and ecological value the people of Puerto Rico have for these rivers. If you are interested in receiving a copy of the study results, please give me your name and address to send you a copy. We want to assure you again, that your name cannot be associated with the answers to the questionnaire.

Yes.....1

No.....2

If your postal address is different from your residential address, please write it for us below if you would like to receive a copy of the findings of this study.

Name: _____

Address: _____

United States
Department
of Agriculture
Forest Service

**Pacific Southwest
Research Station**

Research Paper
PSW-RP-240



Measuring the Economic Benefit of Maintaining the Ecological Integrity of the Río Mameyes in Puerto Rico

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- Participation with other agencies in human resource and community assistance programs to improve living conditions in rural areas
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