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**Working Paper**

## Combining Actual and Contingent Behavior to Estimate the Value of Sports Fishing in the Lagoon of Venice

Nota di Lavoro, No. 44.2005

**Provided in Cooperation with:**

Fondazione Eni Enrico Mattei (FEEM)

*Suggested Citation:* Alberini, Anna; Zanatta, Valentina; Rosato, Paolo (2005) : Combining Actual and Contingent Behavior to Estimate the Value of Sports Fishing in the Lagoon of Venice, Nota di Lavoro, No. 44.2005, Fondazione Eni Enrico Mattei (FEEM), Milano

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Sports Fishing in the Lagoon of  
Venice**

Anna Alberini, Valentina Zanatta  
and Paolo Rosato  
NOTA DI LAVORO 44.2005

**MARCH 2005**

SIEV – Sustainability Indicators and Environmental  
Valuation

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# Combining Actual and Contingent Behavior to Estimate the Value of Sports Fishing in the Lagoon of Venice

## Summary

This paper reports the results of a Travel Cost Method (TCM) study about the recreational use of the Lagoon of Venice for sports fishing. In April-July 2002, we conducted a mail survey of anglers with valid licenses fishing on the Lagoon of Venice to gather data on their fishing trips, behaviors and expenditures over the previous year. We also asked questions about trips that would be undertaken under hypothetical changes in the price of a trip and/or in the catch rate. Actual and hypothetical trips are combined to estimate single-site TCM demand function for trips. We propose several models to test whether it is acceptable to pool hypothetical and actual trip data, focusing on the respondent heterogeneity in the contingent behavior questions. Our models suggest actual and contingent behavior are driven by the same demand function, and can be pooled for estimation purposes. We use this estimated demand function, and its shift when the catch rate is improved, to compute angler surplus at the current catch rate and the change in surplus accruing from a 50% improvement in the catch rate. For the average angler in our sample, the former is about €1,700 a year, while the latter is about €2,800.

**Keywords:** Sports fishing value, Travel cost method, Environmental improvement

**JEL Classification:** Q26, Q51

*We wish to thank Giuseppe Chiaia of the Province of Venice and Andrea Galvan of FEEM for their valuable help in the survey. This research was funded by a research grant from the Consortium for the Coordination and Management of Research on the Lagoon of Venice (CO.RI.LA.) and by additional research funding from the Province of Venice.*

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## 1. Introduction and Background

The Lagoon of Venice is a site of exceptional interest, due to its distinctive hydrological features and ecosystem, and its unique cultural and social significance. As one of the most important wetland sites in the Mediterranean region, the Lagoon of Venice is covered by the European Union's policy for wetlands preservation,<sup>3</sup> and the harvesting of fish and shellfish in the Lagoon is an important local economic activity.

At this time, however, the Lagoon of Venice is environmentally degraded, due to the industrial pollution from plants and refineries in nearby Porto Marghera, nutrient and pesticides in agricultural runoff, and organic pollutants from urban areas and livestock. In addition, overfishing by commercial outfits has depleted fish stocks, and biodiversity is endangered by an exotic clam species that was artificially introduced for commercial fishing during the 1980s. The introduction of the *Tapes philippinarum* clam has been blamed for serious changes in the natural lagoon environment, as harvesting this species involves the use of invasive (and illegal) fishing techniques, such as mechanical scrapers, which were eventually prohibited (Pranovi and Giovanardi [4]; ICRAM [5]).

Public programs are currently under consideration that would seek to restore environmental balance in the Lagoon by reducing pollution and implementing and managing sustainable commercial fishing practices. The latter would result in increased

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<sup>3</sup> European Community Directive 92/43 "Habitat," on conservation, defense and improvement of environmental quality in sites of European Community interest.

fish stocks. In this paper, we use a combination of the travel cost method (TCM) and contingent behavior questions to estimate the benefits of increasing fish stocks for one category of beneficiaries--recreational anglers.

The TCM is a frequently used approach for estimating the benefits of management policies for natural resource sites and environmental amenities that have recreational use value. The method relies on the variation in the travel costs faced by a sample of potential and actual visitors to the site, which allows one to estimate the demand function for trips at different trip prices.

When the proposed policy calls for improving the quality at the site, to estimate the benefits of such improvements it is necessary to trace out demand for trips to the site for a level of site quality that is not currently observed. To circumvent this problem, in recent studies researchers have asked individuals to tell them how many trips they would take to the site under hypothetical conditions, and have combined the responses to these questions—known as contingent behaviors—with observations on actual trips to the site under the current conditions.

Implicit in this approach is the assumption that actual trips and the responses to the contingent behavior questions are driven by the same preferences. If this assumption is violated, serious doubts arise about the usefulness of contingent behavior questions and on the policy prescriptions based on the responses to these questions.

In this paper we propose and implement several possible approaches to detect any differences between the demand functions implied by actual and contingent behavior trips, focusing on the issue of heterogeneity across respondents in their reactions to contingent behavior questions. We propose two alternative models for heterogeneity—

namely, (i) heterogeneity that is linked with observable individual characteristics, and (ii) unobserved heterogeneity.

Our data suggest that our respondents were comfortable with the hypothetical questions, and that their responses to the contingent behavior questions are consistent with actual behaviors. We find no evidence of a systematic hypothetical bias that would undermine the use of the responses to the hypothetical questions for policy purposes, and no evidence of heterogeneity related to individual characteristics in the response to hypothetical changes in catch rates. Random-coefficients models suggest that heterogeneity, if any, is of an unobserved nature, and confirm that there are no systematic hypothetical question effects.

Earlier research about the difference between hypothetical and actual demand functions has produced mixed results. Some studies (e.g., Rosenberger and Loomis [1]) find no systematic differences between actual and hypothetical trips. Azevedo et al. [2] use state and revealed preference data about trips to wetland resources in Iowa to test four hypotheses about responses to contingent behavior questions, concluding that there are inconsistencies between stated and revealed preference data.

Perhaps the most complete study is that conducted by Grijalva et al. [3], who elicit actual and contingent behavior trips to rock climbing sites in Texas, and compare them with actual trips taken after the proposed policy was implemented. These authors find that post-policy trips are more price sensitive than pre-policy trips, but advise that caution should be used in interpreting this result.

In sum, the contribution of this paper is two-fold. First, we produce estimates of recreational sports fishing values at current and improved catch rates. Second, since we

combine actual and hypothetical trips, we propose and estimate formal models of heterogeneity in the response to the hypothetical policy to make sure that actual and hypothetical trips belong to the same demand function. These models nicely supplement conventional ways of testing for differences across actual and hypothetical behaviors, and allow us to conclude that the two types of data can be pooled to estimate the demand for fishing trips at current and improved conditions.

The remainder of this paper is organized as follows. Section II describes the survey design and administration. Section III describes the basic TCM approach and Section IV the econometric model. Section V describes the survey data and section VI presents the estimation results. Section VII reports the welfare variation estimates and section VIII provides concluding remarks.

## **II. Study Design and Administration**

### *A. Study Design*

In April-July 2002, we conducted a mail survey of anglers with valid fishing licenses for the Lagoon of Venice to gather information on their fishing trips to the Lagoon (see Appendix A), and the related expenditures over the previous year. We also asked questions about trips that would be undertaken under hypothetical changes in the price of a trip and in the catch rate. Specifically, we asked them how many trips they would take in a year if the price per trip increased by a specified percentage. This percentage was varied to the respondent, and was selected at random from five possible values (20%, 40%, 60%, 80% and 100%).

Next, we asked respondents how many trips they would take (i) if there was a 50% increase in the catch rate, and (ii) for a simultaneous increase in the price per trip and in the catch rate. This results in a total of four scenarios (current conditions plus three hypothetical situations), for a total of four observations on Lagoon fishing trips for each respondent, as shown in table 1.<sup>4</sup>

The purpose of the hypothetical questions is to (i) refine our information about the demand for trips at the *current* catch rates, and (ii) estimate the shift in the demand curve for trips in the presence of *improved* catch rates. This shift in the demand function is crucial for estimating the benefits of fish stock maintenance to sports anglers.

Because we wanted to make sure that the hypothetical changes in catch rates were acceptable to the respondents, we included in the questionnaire several questions that inquire about the respondent's opinions about and perceptions of environmental quality (pollution) and exotic species (the *Tapes philippinarum* clam) in the Lagoon. We also inquired whether the respondent had previously changed his fishing behavior as a result of such problems.

### *B. Survey Administration*

The survey was administered by mail in April-July 2002. In a first wave of mailings, we sent questionnaires to 3000 anglers. This sample was drawn from the universe of all holders of fishing licenses in the Province of Venice, stratified by distance

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<sup>4</sup> We therefore have more observations on trips per respondent than many studies published in the literature. Rosenberger and Loomis [1], Azevedo et al. [2] and Hanley et al. [6] for example, only have one actual and one hypothetical observation per respondent.



of the angler's place of residence from the Lagoon and age.<sup>5</sup> The survey packet included a participation notice card, which was filled out and returned by about 500 anglers.

In our second wave of mailings, we sent a reminder card to the remaining 2500 anglers. We received about 500 more participation cards after this reminder. In sum, the participation notice card was filled and returned to us by 1048 anglers. Of these, 605 stated that they did not intend to participate in the survey, while the remaining 443 filled out the questionnaire. Out of the latter 443, 269 had gone fishing in the Venice Lagoon in the previous 12 months. In this paper, attention is restricted to these 269 individuals.

### III. The Model

To estimate the value of recreational sports fishing and the welfare change associated with changes in the environmental quality of the Lagoon, we use a single-site TCM of sports fishing in the Lagoon of Venice. The simplest single-site TCM assumes that an individual's utility depends on aggregate consumption,  $X$ , leisure,  $L$  and fishing trips,  $r$ :

$$(1) \quad U = U(X, L, r)$$

The TCM rests on the assumption of weak complementarity between trips and quality at the site,  $q$ . In other words,  $\partial U / \partial q = 0$  if  $r = 0$  (the individual does not care about quality at the site if he or she does not visit the site), and  $r$  is an increasing function of  $q$ . The individual chooses  $X$ ,  $L$  and  $r$  to maximize utility subject to the budget constraint:

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<sup>5</sup> Specifically, we created four areas. The first area is the city of Venice, plus the islands of the Lagoon. The second area is comprised of population centers on the boarder of the lagoon. The third area population centers 5 to 10 kilometers from the Lagoon, and the fourth area is comprised of population centers 10 kilometers or more from the Lagoon.

$$(2) \quad y + w \cdot [\bar{T} - L - r(t_1 + t_2)] = X + (f + P_d \cdot d) \cdot r$$

where  $y$  is non-work income,  $\bar{T}$  is total time,  $t_1$  is travel time to the site,  $t_2$  is time spent at the site,  $f$  is the access fee (if any),  $P_d$  is the cost per kilometer, and  $d$  is the distance to the fishing site.<sup>6</sup>

This yields the demand function for trips:

$$(3) \quad r^* = r^*(y, w, p_r, q)$$

where  $p_r = w(t_1 + t_2) + f + p_d \cdot d$  is the full price of a trip.

In our empirical work, we assume that the demand function is linear in its arguments  $y$ ,  $w$ ,  $p_r$ , and  $q$ . Formally,

$$(4) \quad r^* = \beta_0 + \beta_1 w + \beta_2 p_r + \beta_3 q.$$

On appending an error term, equation (4) becomes an econometric model, which we estimate after collecting data on trips,  $p_r$ ,  $w$ ,  $y$ , and other individual characteristics through our survey of potential and actual Lagoon anglers in the area surrounding Venice.

We have four observations on trips for each respondents, and two sources of variation for  $p_r$  and  $q$ , which is here the catch rate: (i) across anglers, and (ii) across scenarios within one angler. These sources of variation should be adequate to estimate the slope of the demand function,  $\beta_2$ , and the effect ( $\beta_3$ ) of public programs currently under consideration that affect water quality and fish stocks, and hence catch rates.

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<sup>6</sup> This model further assumes that travel time and time spent at the site are given and exogenous, that there is no utility or disutility from traveling to the site, and that each trip to the site is undertaken for no other purpose than fishing. It also assumes that individuals perceive and respond to changes in travel costs in the same way they would to changes in a fee for being admitted to the site (Freeman, [7]). Finally, the model assumes that work hours are flexible. The model can be easily amended to allow for endogenous travel and visit times, and for fixed work hours.

## IV. The Econometric Model

### A. Basic Econometric Model and Welfare Calculation

Absent any response effects due to the hypothetical scenario, our regression equation is:

$$(5) \quad TRIPS_{ij} = \mathbf{x}_i\beta + p_{ij}\gamma + catchrate_{ij}\delta + p_{ij}^A\lambda + \varepsilon_{ij}$$

where  $i = 1, 2, \dots, n$  denotes the respondent, and  $j = 1, \dots, 4$  denotes the scenario.  $TRIPS$  is the number of trips per year,  $\mathbf{x}$  is a vector of individual characteristics,  $p$  is the cost per fishing trip, and  $catchrate$  is catch rate, measured in kilograms of fish caught per trip.  $P^A$  is the price per trip to an alternative fishing destination. (It is also useful to define a dummy indicator,  $Catch_j$ , that takes on a value of one for those scenarios—scenarios 2 and 4—that posit an improved catch rate.)  $\beta$ ,  $\gamma$ ,  $\delta$  and  $\lambda$  are unknown coefficients, and  $\varepsilon_{ij}$  is an error term.<sup>7</sup>

One caveat is in order. The observations on fishing trips under the four scenarios are correlated within an individual if unobservable angler characteristics influence both current fishing trips and the announced number of trips under the hypothetical scenarios. We therefore adopt a random-effects specification, where we assume that  $\varepsilon_{ij} = \nu_i + \eta_{ij}$ , with  $\nu_i$  a respondent-specific, zero-mean component, and  $\eta_{ij}$  an i.i.d. error term.  $\nu_i$  and  $\eta_{ij}$  are uncorrelated with each other, across individuals, and with the regressors in the right-hand side of equation (5). The presence of the individual-specific component of the

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<sup>7</sup> As explained below, our respondents reported numerous trips (an average of about 30) to the Lagoon every year, which makes the linear model desirable for this specific application.

error term ( $\nu_i$ ) result in correlated error terms  $\varepsilon$  within a respondent.<sup>8</sup> This means that the model must be estimated using Generalized Least Squares.<sup>9 10</sup>

The estimated coefficients are used to calculate two welfare measures. The first captures the value of access and is the consumer surplus associated with current fishing conditions and prices:

$$(6) \quad CS_i(p_{0i}, cr_{0i}) = -\frac{1}{2\gamma} [\mathbf{x}_i\beta + p_{0i}\gamma]^2.$$

The second captures the value of changes in the quality of the Lagoon of Venice as a fishing site, and is the change in surplus due to an improvement in catch rate (holding the prices the same):

$$(7) \quad \Delta CS_i = CS_i(p_{0i}, cr_{1i}) - CS_i(p_{0i}, cr_{0i}) = -\frac{1}{2\gamma} [\delta^2 + 2\delta(\mathbf{x}_i\beta + p_{0i}\gamma)].$$

Figure 1 depicts the consumer surplus with and without the improvement in the catch rate, assuming for the sake of simplicity that the catch rate variable in the econometric equation is a dummy. The surplus with the improvement in the catch rate is equal to the area of the triangle AED while the surplus without the improvement is equal to the area BEC. So the improvement in the CS is equal to the area ABCD.

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<sup>8</sup> Specifically,  $E(\varepsilon_{ij}\varepsilon_{ik}) = \sigma_v^2$ , where  $\sigma_v^2$  is the variance of  $\nu$ , for  $j \neq k$ , whereas the variance of each  $\varepsilon_{ij}$  is  $\sigma_v^2 + \sigma_\eta^2$ , where  $\sigma_\eta^2$  is the variance of  $\eta$ .

<sup>9</sup> When the price of a trip is raised, some individuals state that they would stop going fishing altogether. We experimented with a tobit model with random effects, and found that its coefficients were virtually identically to those of the linear model with random effects. Given the difficulty of estimating a *random-coefficient* model (see below) superimposed to the tobit equation, in this paper we choose to present the results based on the linear model.

<sup>10</sup> Another application that resulted in the estimation of random-effect models is described in Hanley et al. [6], who survey beachgoers at five Scottish beaches, asking them to report the number of beach visits, plus the number of beach visits that they would undertake if water quality was improved to meet European Union standards. Hanley et al. pool the data from hypothetical and actual trips, but do not test for hypothetical response effects. In their regressions quality is measured using the Likert scale score assigned subjectively by the respondent to water quality, rather than an objective measure of water quality.

### B. Testing for Hypothetical Questions Effects

Equation (5) posits that when the price and the catch rate are varied to the respondents in the hypothetical scenarios, the effect on trips is the same as what would be observed through the cross-sectional variation in actual prices and catch rates. As previously explained, it is important to test if this assumption is borne out in the data.

This can be done by amending equation (5) to include a dummy variable, henceforth denoted as *Catch*, which takes on a value of one for the observations corresponding to scenarios 2 and 4, which posit improved catch rates. Formally, the new regression equation is

$$(8) \quad TRIPS_{ij} = \mathbf{x}_i\beta + p_{ij}\gamma + catchrate_{ij}\delta_1 + Catch\delta_2 + p_{ij}^A\lambda + \varepsilon_{ij}.$$

We wish, therefore, to test the null hypothesis that  $\delta_2 = 0$ . Implicit in this testing procedure is the assumption that any hypothetical bias in the contingent behavior responses is constant across individuals.

It is, however, possible that the difference between the demand functions implied by actual and contingent behaviors, if any, varies across anglers. For example, it might be argued that the plausibility of the improved scenarios (and hence the reliability of the angler's response) varies with the past fishing experiences and skills, education, age, and perceptions of pollution.

Clearly, this type of heterogeneity in the reaction to the contingent behavior questions is related to observable variables. To see if this is the case, we add in the right-hand side of the model interactions between the *Catch* dummy and variables these factors. Rejection of the null that the coefficient(s) on the interaction(s) is (are) equal to

different from zero would support the notion of observable heterogeneity in the reaction to the contingent behavior questions.

Finally, we allow for the possibility that there is heterogeneity in the response to the contingent behavior question about catch rate, but that this heterogeneity cannot be linked with observable characteristics. We propose to model this unobserved heterogeneity by fitting a random-coefficient regression equation. Formally,

$$(9) \quad TRIPS_{ij} = \mathbf{x}_i\beta + p_{ij}\gamma + catchrate_{ij}\delta_1 + (Catchrate \times Catch)\delta_{2i} + p_{ij}^A\lambda + \varepsilon_{ij}$$

Where  $\delta_{2i}$  is a random coefficient that varies across respondent, but is fixed across the observations contributed by the same angler. In other words, we assume that  $\delta_{2i} = \bar{\delta}_2 + \xi_i$ , where  $\bar{\delta}_2$  is the expectation of  $\delta_{2i}$ , and  $\xi_i$  is a normally distributed error term with mean zero and variance  $\sigma_\xi^2$ . Equation (9) can, therefore, be re-written as

$$(10) \quad TRIPS_{ij} = \mathbf{x}_i\beta + p_{ij}\gamma + catchrate_{ij}\delta + (CCrate_{ij})\bar{\delta}_2 + p_{ij}^A\lambda + [\varepsilon_{ij} + CCrate_{ij} \cdot \xi_i],$$

Where  $CCrate = catchrate \times catch$ , and all unobserved terms have been gathered inside the brackets.

In equation (10), the  $\varepsilon$  terms are iid and that they do not contain any individual-specific effects. By contrast, the overall errors—the terms in the brackets—are heteroskedastic *and* correlated overall an individual angler, due to the presence of the  $\xi$ s. It is easily shown that the variances of the term in the brackets are equal to  $\sigma_\varepsilon^2 + \sigma_\xi^2 \cdot CCrate_i^2$ , and that the covariance between any two error terms within the same individual is  $\sigma_\xi^2 \cdot CCrate_{ij} \cdot Ccrrate_{ik}$  for  $j \neq k$ . The error terms in the brackets in (10) are uncorrelated across anglers.

Model (10) is, therefore, estimated by (feasible) generalized least squares by minimizing

$$(11) \quad \sum_{i=1}^n [\mathbf{y}_i - \mathbf{Z}_i \boldsymbol{\theta}]' \mathbf{A}_i^{-1} [\mathbf{y}_i - \mathbf{Z}_i \boldsymbol{\theta}],$$

where  $\mathbf{y}$  is a  $4 \times 1$  vector of observations on trips,  $\mathbf{Z}$  is a matrix of suitable dimensions with all the right-hand side variables of equation (10),  $\boldsymbol{\theta}$  is the vector of all regression coefficients in (10), and  $\mathbf{A}$  is the matrix of error variances and covariances within individual  $i$ . We adopt an iteratively re-weighted least squares algorithm to obtain the GLS estimates.

### *C. The Choice of Regressors in the Econometric Model*

Economic theory suggests that the demand for fishing trips should depend on the full price of a trip, which includes the opportunity cost of time (see section 2).<sup>11</sup> Measuring the opportunity cost of time, however, is fraught with difficulties,<sup>12</sup> which is the reason why we prefer to enter out-of-pocket price (*pricee*<sup>13</sup>) and income separately in our model.

We further include (i) household income divided by the number of household members (PCAPINC), (ii) a dummy that takes on a value of one if the respondent did not

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<sup>11</sup> Earlier literature (since Cesario, [8]) has suggested that the opportunity cost of time should be about one-third of the market wage rate, and McConnell and Strand [9] have suggested an approach for estimating this fraction directly from the data reported by the respondent in a TCM survey. Recently, Feather and Shaw [10] [11] have proposed approaches for computing the value of time for individuals who are employed but do not choose the number of hours they work, and for individuals who choose not to work.

<sup>12</sup> Azevedo et al.[2] argue that the opportunity cost of price is likely to be measured with error, and that this may be well be one possible reason for differences in the slope of the actual and hypothetical demands for trips.

<sup>13</sup> *Pricee* is the sum of boat fuel costs, the cost of the car trip (fuel, wear-and-tear, and highway toll), the fee for launching the boat from a boat ramp, the cost of bait, and food and beverages.

answer the question about household income,<sup>14</sup> and (iii) a dummy (RETIRED) indicating whether the respondent is retired from the workforce, which captures time constraints, among other things.

When estimating a single-site TCM model, it is important to control for the price of a trip to an alternative site. Due to the extension of the Lagoon of Venice, its location, nature and species, there are very few sites that may serve as substitutes for it for sports fishing. We argue that only the Lagoon of Marano serves as a reasonable substitute for it, but only for those anglers in our sample that are not residents of Venice. For logistical reasons, the latter would find it extremely time consuming and costly to get their cars and drive to the Lagoon of Marano, with their boats in tow. Accordingly, we control for the travel cost to a substitute site by including the price of a trip to Marano (MARANO2), plus a dummy denoting whether the angler is a resident of the city of Venice. If so, we recode MARANO2 to zero. Finally, we include an additional regressor, BOAT, a dummy variable denoting use of the angler's own boat to go fishing.

## **V. The Data**

### *A. Fishing Trips and Socio-demographics*

The sample we examine in this paper is comprised of 269 individuals who report having taken fishing trips in the Lagoon of Venice over the last 12 months.

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<sup>14</sup> Specifically, we create a dummy (PCAPINCMISS) taking on a value of one for those respondents who did not answer the household income question. If PCAPINCMISS=1, we recode income per household member (PCAPINC) to zero. Both PCAPINC and PCAPINCMISS must be entered in the right-hand side of the regression. The latter variable captures any systematic differences in fishing trips among those respondents who did and did not report information about their incomes. The coefficient of PCAPINC captures the net effect of the opportunity cost of time and any other ways in which income affects the demand for trips.



Descriptive statistics of the sample are reported in table 2. As shown in table 2, virtually all of the anglers in our sample are males. The average respondent is about 50 years old, has had about 10 years of schooling, and has an annual household income of €20,000. Retired persons account for about one-third of the sample.<sup>15</sup>

Regarding fishing behavior and experience, the average respondent reports taking about 30 trips a year in the Lagoon, for a total expenditure of about €765 a year. The average cost per trip is €31. On average, our anglers have been fishing in the Lagoon for 26 years, and more than 50% use their own boat on their Lagoon fishing trips.

In analyses not reported in this paper, we also found that Fascia A (=city of Venice) residents tend to be slightly older than the residents of other areas, their average age being 55 years versus 45-49. The Fascia A subsample tends to include more retired persons than the remainder of the sample (40% versus 15-39%). The average cost of a fishing trip is similar across zones, but Fascia A respondents take more fishing trips than the others (see Alberini et al. [12]).

### *B. Fishing Trips by Scenario*

Under the current conditions, our subjects reported an average of 30 trips to the Lagoon in the 12 months prior to the survey. About 39 percent of the respondent took one to 12 trips, 35 percent took 13-30 trips, and 26 percent took more than 30.

When asked to consider a hypothetical situation with higher prices per trip, respondents announced that they would either keep the number of trips the same, or that

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<sup>15</sup> The proportion of retired persons among Lagoon anglers is higher than among all holders of fishing license in the Province of Venice (18.3 %). The reason is that Lagoon sport fishing is closely related to traditional fishing in the Lagoon and hence requires plentiful time. Furthermore, the average age of people living in the historical center of Venice is higher than the one living outside.

they would take fewer trips. The average number of trips per year under scenario 2 is 14, with 38% of the respondents stating that they would no longer go fishing.

Under scenario 3, which has higher catch rates, people generally told us that they would take more trips, for an average of almost 39 per year. Under scenario 4, which posits higher prices and a higher catch rate, the average number of announced trips is 21, with 28% of the respondents reporting an intended number of trips equal to zero.

These figures suggest that the responses to the hypothetical trip questions are reasonable and consistent with well-behaved demand functions.<sup>16</sup>

### *C. Perception of Environmental Quality in the Lagoon of Venice*

Our questionnaire also queries anglers about their perception of environmental quality in the Lagoon. We use three questions to explore this matter. The first asks whether the presence of chemical pollutants and industrial waste in the Lagoon is thought to affect catch rates. The second question asks the respondents if they feel that catch rates have been negatively affected by the introduction of the *tapes philippinarum* clam. The third question asks the respondent if he has changed his own fishing behavior as a result of pollution and this new species. Two response categories (yes and no) are provided for each of these questions.

We found that the majority of our respondents (91.9%) thought that pollution influences catch rates in the Lagoon. Eighty-two percent of our anglers felt that catch rates had been negatively impacted by the introduction of the *tapes philippinarum* clam,

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<sup>16</sup> These aggregate figures suggest that the elasticity of trips with respect to price is roughly one, while that with respect to catch rate is roughly 0.6. This is broadly consistent with the characteristics of the sample, and with the presence of many retired persons with low incomes and high trip rates at the current conditions.

and 78% of them have actually changed their own fishing behavior as a result of pollution and exotic species. These response patterns suggest that anglers are aware of the potential effects of water quality and exotic species on catch rate, and they should accept hypothetical scenarios where improvements in catch rates are delivered by water quality and fishing management policies.

## **VI. Results**

### *A. Models of Actual Trips*

We begin our analysis with reporting and discussing the results of an OLS regression where the sample is restricted to actual trips. The results of this run are reported in table 3, column (A).

In this regression, the coefficient on price per trip is negative, as expected, and significant. Its magnitude, -0.14, implies that it takes an increase in price per trip of 10 euro to see a decrease of 1.4 in expected trips. The coefficient on MARANO2 is positive, as expected for the price of a substitute site, but insignificant, and that on FASCIAA is 15.34, implying that Venice residents take on average 15 more fishing trips than persons who live elsewhere in the study region.

The coefficient on CATCHRATE is large and significant. Any additional kilo of fish per trip raises fishing trips by almost 10 a year. Regarding income, the coefficient on this variable is negative, suggesting that it indeed captures the opportunity cost of time. The effect is strongly significant. Those persons who did not report their income are not significantly different from those who did in terms of trips, despite the large coefficient on PCAPINCM. Retired persons and boat owners take more trips than the other

respondents, but the coefficients on these dummies are estimated imprecisely and only that on the latter is significant (at the 10% level).

### *B. Random-effects Models, Full Panel*

In columns (B)-(D), we report the results of regressions that exploit the full panel of data, including intended trips at hypothetical conditions. To see the effect of the hypothetical trip data, compare column (B) with column (A): The coefficient on price in column (B) is -0.13, changing by less than 6% with respect to its counterpart in A. We conclude that the responses to the contingent behavior questions do not alter the slope of the demand function estimated using actual trips.

We therefore turn to examining whether this is true of the quality variable, the catch rate. The coefficient on catch rate in column (B) is 5.54, and is thus much lower (a 43% reduction) than the estimate we obtained from the cross-sectional regression that uses only actual trips.<sup>17</sup>

In column (C), we add the CATCH dummy to capture any differences in the sensitivity to the quality of the Lagoon across actual and contingent behavior trips. The coefficient on catch is negative, which is consistent with the changes observed from (A) to (B), but insignificant. The coefficients on the other regressors are similar to their counterparts in (B).

Our first check for possible heterogeneity across respondents in their sensitivity to contingent changes in catch rate is shown in column (D), where we drop CATCH and

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<sup>17</sup> The coefficients on the remaining variable are similar to their counterparts in (A), except for that on income, which changes by 22%. The error terms within a respondent are indeed correlated, as implied by the random effects models, and the correlation coefficient between any two of them is 0.58.

enter the interaction term  $CATCH \times CATCHRATE$ . This, however, results in an insignificant coefficient and brings little changes relative to (B) and (C). This implies that anglers do not react to hypothetical catch rates any differently than we would infer from the cross-sectional variation in actual rates.

Table 4 reports selected coefficients from random-effects models that include  $CATCHRATE$ ,  $CATCH$  and various interactions between  $CATCH$  and individual characteristics of the respondent. We find little evidence of any effects that depend on observable characteristics of the respondent.

Next, we check whether the demand for trips and the sensitivity to hypothetical catch rates varies with the beliefs held by the respondent about pollution and with whether he has previously adjusted fishing behavior in reaction to the quality of the Lagoon. We do so by fitting separate regressions for two groups of respondents—those who did and did not change fishing behavior ( $CAMBIA=1$  or  $0$ , respectively)—but, as shown in table 5, found no differences across the estimated demand functions. We attempted the same approach for  $INQUI$  and  $VOGO$ , but this time one of the two groups was too small to result in a meaningful demand functions.

The estimation results for our preferred specification of the random-coefficients model are displayed in table 6. This specification can be compared to the random-effects model of (D) in table 3. There is evidence of some heteroskedasticity across respondents and correlation of the responses within anglers, as implied by the estimates of  $\sigma_{\xi}$  and  $\sigma_{\varepsilon}$ , but no evidence of a systematic hypothetical bias to changes in catch rates.

## **VII. Welfare Estimates**

We use the simplest specification of our random-effects model (column (B), table 3) to predict angler surplus at the current conditions and the surplus change for a 50% improvement in catch rates. Surplus figures are displayed in table 7. At the average price per trip (€31.23) and income per household member (€7920.64 a year) in our sample, surplus at the current conditions is pegged at €1,774 a year, while the welfare change associated with the catch rate improvement is €1,056 a year.

The welfare calculations can be specialized to the residents of Venice (FASCIAA=1) and of the other areas in our sample (FASCIAA=0). Holding the price per trip the same across these two groups, but setting income per household member to €8474.55 for Venice residents and to €7391.00 for all others, we obtain surplus figures at the current conditions of €3043 a year for Venice residents and €769 a year for all others. A 50% change in catch rates yields surplus changes of €1379 a year for Venice residents and €745 a year for all others.

We use these two strata—residents of Venice (FASCIAA=1) and all others (FASCIAA=0)—to estimate the benefits of improvements of the sports fishing activity. We denote our welfare measure of interest with  $S(\mathbf{x}_k, \hat{\beta})$ , where  $\mathbf{x}_k$  is a vector of regressors and  $\hat{\beta}$  is a vector of estimated coefficients. The welfare measure for the population is, therefore, equal to:

$$(12) \quad S = \sum_{k=1}^2 S(\mathbf{x}_k, \hat{\beta}) \cdot N_k,$$

where  $N_k$  is the number of Lagoon anglers in stratum  $k$  in the population,  $k=1$  denotes Venice residents and  $k=2$  Lagoon anglers who reside in other areas.  $S(\mathbf{x}_k, \hat{\beta})$  is the surplus at the current conditions in our first estimation exercise, and the welfare change

for stratum  $k$  associated with the catch rate improvement in our second estimation exercise.

For simplicity, in this paper attention is restricted to those anglers who currently go fishing in the Lagoon of Venice, ignoring the possibility that improvements in catch rates might entice other persons to go fishing in the Lagoon. This assumption leads to conservative benefit estimates.

No one knows exactly  $N_1$  and  $N_2$ , the populations of Lagoon anglers that reside in Venice and in all other areas, respectively. In this paper, we offer estimates of these populations based on conservative assumptions.<sup>18</sup> We start with pointing out that the universe of fishing licenses valid in the Province of Venice is comprised of a total of 34018 persons. Of these, 4415 are residents of Venice and Lagoon islands, while the remaining 29603 live in other areas (for the most part, the inland portion of the Province of Venice, with some residents of the Provinces of Treviso and Padua).<sup>19</sup>

The first estimate is based on the conservative assumption that only the holders of fishing licenses that actually go fishing in the Lagoon bother to return the completed questionnaire,<sup>20</sup> and that our sample reflects the Lagoon fishing participation rates of the population. Since the questionnaire was returned by 13.4% of the recipients with Venice and Lagoon islands addresses, and 7.1% of the other recipients, we estimate  $N_1$  to be equal to  $(4415 * 0.134) = 591$  and  $N_2$  to be equal to  $(29603 * 0.071) = 2102$ . The surplus associated with current fishing conditions is, therefore, €1,798,773 a year for Venice

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<sup>18</sup> See Alberini et al. [12] for an alternate, and more generous, calculation of  $N_1$  and  $N_2$ .

<sup>19</sup> We remind the reader that  $N_1$  and  $N_2$  are not the same as the number of holders of valid fishing licenses for the Province of Venice that reside in Venice and in other areas, respectively. This is because purchase of the fishing license entitles access to and use of many bodies of water in the Province of Venice, of which the Lagoon of Venice is only one.  $N_1$  and  $N_2$  are, therefore, less than or equal than 4415 and 29603, respectively.

residents and €1,617,047 for residents of other areas who go fishing in the Lagoon, for a total of €3,415,820 a year. The welfare change figures associated with a 50% improvement in catch rates are €812,113 and €1,566,620, for a total of €2,378,733 a year.

We remind the reader that these figures are not the only benefits of a proposed fish stocks maintenance policy: The total benefits include the benefits experienced by other categories of beneficiaries of the policy, such as commercial fishing outfits, other types of recreationists, plus the benefits of those anglers who start fishing as a result of the improved catch rates in the Lagoon. Once the full benefits of the policy are estimated, they can be compared with the costs of the program in a full-blown benefits-cost analysis.

### **VIII. Discussion and Conclusions**

We have surveyed anglers who go fishing in the Lagoon of Venice to gather information about the frequency of their Lagoon fishing trips and cost incurred. We have then used this information to estimate a single-site TCM equation explaining trips as a function of cost per trip and other factors. In doing so, we have augmented our observations on actual trips and costs with the trips our respondents told us they would undertake under hypothetical changes in the cost per trip and in the catch rate. This additional information has allowed us to improve the efficiency of our estimate of the slope of the trip demand function. It has also allowed us to estimate the shift in the demand function associated with a 50% improvement in catch rate.

One key aspect of our research is the care we have taken to check that the responses to hypothetical scenarios reflect the same preferences as actual trips. We have

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<sup>20</sup> Under this assumption, a person who received the questionnaire but did not fill it out is held to never go fishing in the Lagoon.



(a) compared demand functions based on actual and pooled actual-hypothetical trips, (b) estimated models with pooled data with dummies to check for hypothetical effects, and (c) tested extensively for heterogeneity in the response to the hypothetical scenario questions. In (c), we checked for both heterogeneity linked to observable characteristics of the responses, and to unobservable heterogeneity, which resulted in random-coefficient models.

We found no evidence that the responses to the actual and hypothetical questions are driven by different sets of preferences. Our results can be compared with those of Rosenberger and Loomis [1], who report no significant differences in the slope of the demand function for trips across actual and contingent behaviors. Azevedo et al. [2] find that there *are* significant differences in the coefficients on price across actual and hypothetical trips. In their study, people tend to be more responsive to price in the revealed preference data.<sup>21</sup> (Azevedo et al. [2], however, are careful to point out that the price of a trip is likely to be measured with an error, since the opportunity cost of time, one of the components of the price per trip, is imputed by the researcher.) By contrast, Grijalva et al. [3] find that pre-policy trips are less price-sensitive than post-policy trips.

Various cross-checks in our questionnaire further confirm that our data are reasonable and credible. Based on the results of our econometric models and on other evidence from our data, we believe that, with the due caution, our figures could be used for policy purposes. We illustrate a possible policy use of our figures by computing total surplus of access to the Lagoon of Venice, and the surplus change associated with policies that improve catch rates.

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<sup>21</sup> By contrast, respondents gave heavier weight to the wage rate in the hypothetical scenarios.

To compute the population surplus and surplus change, it is necessary to multiply the surplus (surplus change) by the number of anglers who do fish in the Lagoon. No one knows exactly how many anglers visit the Lagoon, and how many of these anglers are Venice residents or residents of other areas. Based on conservative assumptions about the total number of Lagoon anglers, we obtain estimates of surplus at the current conditions of €3.4 million and of surplus change if catch rates improve of €2.4 million a year. Conversations with officials of the Province of Venice suggest that this conservative assumption is reasonable.

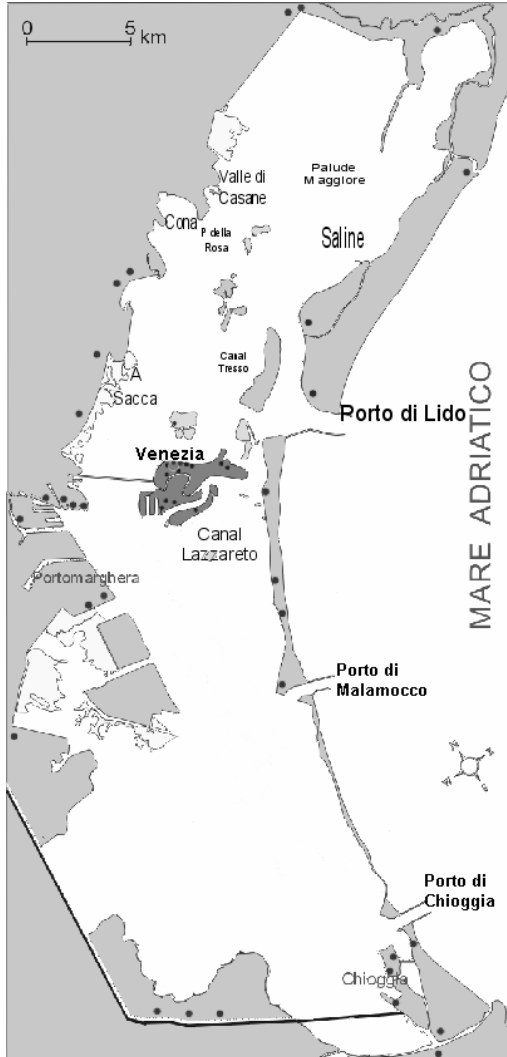
It should be kept in mind, however, that our calculations do not account for persons who do not go fishing in the Lagoon at this time, but could be enticed to do so if catch rates improved. Moreover, any benefit-cost analyses of proposed policies that seek to improve environmental quality and fish stocks in the Lagoon should also examine the benefits brought by these policies to other categories of beneficiaries, in addition to Lagoon anglers.

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**Appendix A. Lagoon of Venice.**



## Tables

Table 1. Survey Design.

Scenario	Type	Price per trip	Catch rate
1	Actual	Actual price per trip ( $p_{i0}$ )	Current conditions ( $cr_{i0}$ )
2	Hypothetical	Higher price: ( $p_{i1} = (1+X)p_{i0}$ ), where X is selected at random out of {0.20, 0.40, 0.60, 0.80, 1.00}	Current conditions ( $cr_{i0}$ )
3	Hypothetical	Actual price per trip ( $p_{i0}$ )	Increase of 50% over current conditions: $cr_{i1} = cr_{i0} \cdot (1 + 0.5)$
4	Hypothetical	Higher price: ( $p_{i1} = (1+X)p_{i0}$ ), where X is the same as in scenario 2	Increase of 50% over current conditions: $cr_{i1} = cr_{i0} \cdot (1 + 0.5)$

Table 2. Descriptive statistics for the sample (n=269).

Variable	Sample average (standard deviation in parentheses)
<i>Individual characteristics of the respondent</i>	
Age (ETA) (years)	51.22 (14.74)
Male (SEX) (dummy)	0.985 (0.12)
Annual Household income* (INCOME)	€ 20524 (€ 15389)
Does not report INCOME (PCAPINCM) (dummy)	0.078 (0.26)
Annual Income per member of the household* (PCAPINC)	€7920.64 (6351.51)
Retired person (RETIRED) (dummy)	0.334 (0.47)
Years of schooling (EDUCATION)	9.80 (3.83)
<i>Fishing behavior and experience</i>	
Price per trip to the Lagoon of Venice (PRICEE)	€ 31.23 (€ 37.89)
Number of fishing trips in the Lagoon in the last 12 months (QVPLA)	30.28 (35.30)
Uses own boat to go fishing (BOAT) (dummy)	0.580 (0.49)
Numbers of years the respondent has been fishing in the Lagoon (DQAP)	26.37 (16.76)
Price per trip to the Lagoon of Marano (MARANO2)	€ 23.07 (€ 40.76)
Catch rate (CATCHRATE) (kilograms per trip)	2.98 (1.05)

\* Calculated for those respondents who do report household income.

Table 3 – Travel cost models. Dependent variables: fishing trips per year (t statistics in parentheses).

	Model A	Model B	Model C	Model D
Constant	-1.2160 (0.16)	4.1878 (0.86)	2.9441 (0.55)	0.2202 (0.04)
PRICEE	-0.1432 (-2.29)	-0.1348 (-4.01)	-0.1340 (-4.00)	-0.1345 (-4.00)
MARANO2	0.023 (0.24)	0.0253 (0.51)	0.0257 (0.50)	0.0260 (0.52)
FASCIAA	15.3402 (2.63)	12.7319 (2.95)	12.6532 (2.93)	12.5660 (2.90)
CATCHRATE	9.7307 (5.20)	5.5488 (7.94)	6.0869 (5.26)	7.0868 (4.30)
CATCH			-1.2611 (-0.58)	
CATCHRATE * CATCH				-0.6643 (-1.03)
PCAPINC	-0.0009 (-2.81)	-0.0007 (-2.36)	-0.0007 (-2.36)	-0.0007 (-2.35)
PCAPINCM	-6.9558 (-0.89)	-5.2754 (-0.78)	-5.0007 (-0.74)	-4.6936 (-0.69)
RETIRED	6.5931 (1.60)	5.8301 (1.62)	5.7966 (1.61)	5.7597 (1.60)
BOAT	7.8550 (1.85)	6.4257 (1.76)	6.2177 (1.69)	5.9859 (1.63)
R-square	0.2351	0.1625	0.1638	0.1648
N	267	1068	1068	1068
$\hat{\sigma}_\varepsilon$	30.85			
$\hat{\sigma}_v$		25.24	25.23	25.24
$\hat{\sigma}_\eta$		21.30	21.31	21.30
correlation		0.5840	0.5837	0.5840

Model A = linear regression model, only 1 observation per person, actual number of trips only. Model B, C, D = linear models, random effects, 4 observations per person.

Table 4. Random-effects models to test for systematic heterogeneity in the response to the hypothetical catch rates. (t statistics in parentheses).

	Model I	Model II	Model III	Model IV	Model V	Model VI	Model VII	Model VIII
Constant	2.9489 (0.55)	4.4460 (0.83)	4.2641 (0.79)	3.5828 (0.67)	2.3415 (0.43)	2.1606 (0.40)	2.2580 (0.43)	2.7515 (0.44)
PRICEE	-0.1345 (-4.00)	-0.1347 (-4.01)	-0.1336 (-3.97)	-0.1339 (-3.98)	-0.1345 (-4.00)	-0.1345 (-4.00)	-0.1369 (-4.08)	-0.1351 (-4.01)
MARANO2	0.0256 (0.51)	0.0256 (0.51)	0.0244 (0.49)	0.0249 (0.50)	0.0256 (0.51)	0.0256 (0.51)	0.0288 (0.58)	0.0263 (0.52)
FASCIAA	12.6528 (2.93)	10.2937 (2.28)	10.7122 (2.39)	11.6900 (2.63)	12.6512 (2.92)	12.6424 (2.92)	13.0117 (3.02)	12.6093 (2.91)
CATCHRATE	6.0872 (5.26)	5.9651 (5.15)	5.9594 (5.14)	6.0150 (5.19)	6.0993 (5.27)	6.1592 (5.31)	6.1730 (5.36)	6.1452 (5.25)
CATCH	-1.2735 (-0.54)	-3.4134 (-1.39)	-2.9364 (-1.23)	-2.0777 (-0.89)	-0.1432 (-0.05)	-0.1983 (-0.08)	3.7258 (0.99)	-0.5436 (-0.11)
PCAPINC	-0.0006 (-2.36)	-0.0006 (-2.36)	-0.0006 (-2.37)	-0.0006 (-2.34)	-0.0006 (-1.98)	-0.0006 (-2.36)	-0.0006 (-2.17)	-0.0006 (-2.34)
PCAPINCM	-5.0005 (-0.74)	-5.0627 (-0.75)	5.0772 (-0.75)	-5.0658 (-0.75)	-4.9943 (-0.74)	-4.9637 (-0.73)	-4.6892 (-0.70)	-4.9304 (-0.72)
RETIRED	5.7783 (1.50)	5.8051 (1.61)	5.7553 (1.59)	5.8590 (1.62)	5.7956 (1.61)	5.7919 (1.61)	5.2567 (1.46)	5.7446 (1.59)
BOAT	6.2172 (1.69)	6.2658 (1.70)	6.3123 (1.71)	6.2058 (1.69)	6.2127 (1.69)	7.1977 (1.85)	6.2507 (1.71)	6.2974 (1.71)
CATCH*RETIRED	0.0358 (0.01)							
CATCH*FASCIAA		4.7567 (1.82)						
GEOAWARE1 (=INQUI*FASCIAA* CATCH)			4.2205 (1.62)					
GEOAWARE2 (=CAMBIA*FASCIAA* CATCH)				2.5166 (0.95)				
CATCH*PCAPINC					-0.0001 (-0.70)			
CATCH*BOAT						-2.0162 (-0.76)		
CATCH*EDUC							-0.5220 (-1.63)	
CATCH*INQUI								0.7032 (0.16)
CATCH*CAMBIA								-1.5521 (-0.51)
CATCH*VOGO								-0.2828 (-0.09)
R-square	0.1638	0.1646	0.1636	0.1630	0.1640	0.1640	0.1686	0.1645
N	1068	1068	1068	1068	1068	1068	1068	1068
$\hat{\sigma}_v$	25.23	25.24	25.27	25.22	25.23	25.23	25.01	25.32
$\hat{\sigma}_\eta$	21.32	21.27	21.27	21.29	21.31	21.31	21.31	21.34
correlation	0.5833	0.5846	0.5852	0.5838	0.5835	0.5834	0.5794	0.5845



Table 5. Estimated coefficients for selected regressors in random effects models for various groups of respondents.

	CAMBIA=0 (n=232)	CAMBIA=1 (n=836)	INQUI=0 (n=92)	INQUI=1 (n=976)	VOGO=0 (n=194)	VOGO=1 (n=876)
CATCHRATE	5.6709 (t = 1.90)	6.0652 (t = 4.98)	Too unstable to compare		Too unstable to compare	
CATCH	-0.3669 (t = -0.07)	-1.3156 (t = -0.56)	Too unstable to compare		Too unstable to compare	

CAMBIA=dummy equal to one if the respondents changed behaviors in response to perceived pollution problems.

INQUI= dummy equal to one if the respondents perceive that pollution problems have seriously damaged the lagoon environment.

VOGO= dummy equal to one if the respondents perceive that *tapes philippinarum* introduction has seriously changed the natural lagoon environment.

Table 6. Random-coefficient model of trips (t statistics in parentheses).

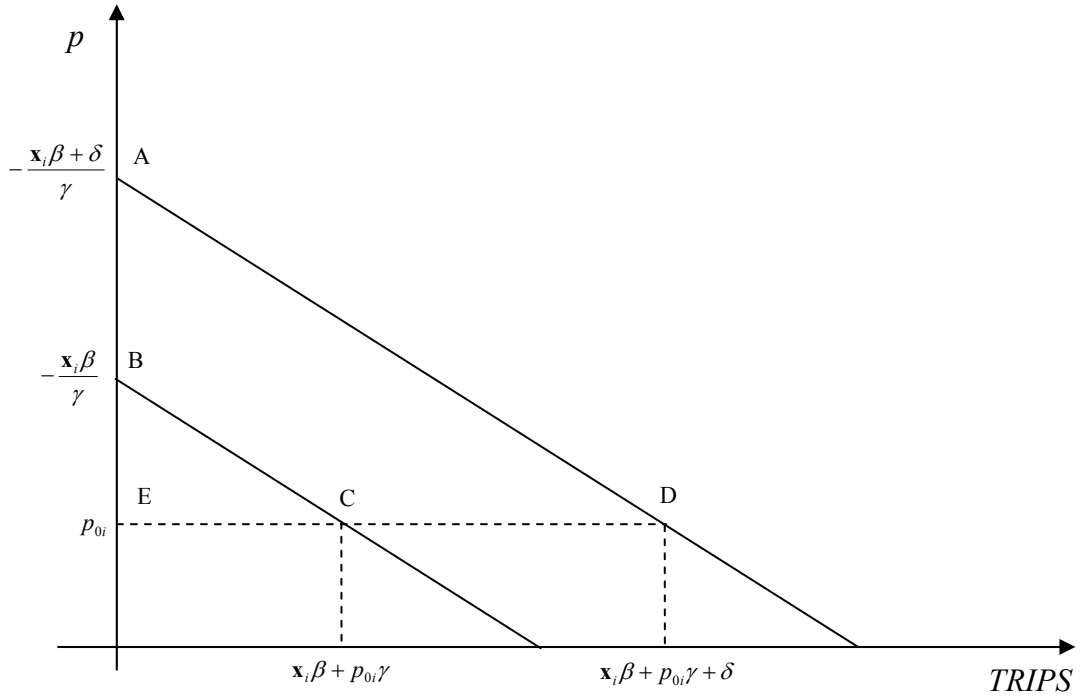
Constant	-1.0358 (-0.28)
PRICEE	-0.1414 (-4.26)
MARANO2	0.0873 (1.83)
FASCIAA	13.8549 (4.55)
CATCHRATE	6.4503 (6.56)
CATCHRATE * CATCH	-0.4531 (-0.81)
PCAPINC	-0.0007 (-3.86)
PCAPINCM	-1.3546 (-0.35)
RETIRED	5.8253 (1.67)
BOAT	7.7506 (3.55)
N	1068
$\hat{\sigma}_{\xi}$	27.64
$\hat{\sigma}_{\varepsilon}$	28.57

Table 7. Surplus and surplus changes after 50% catch rate improvement.  
Based on specification (B), table 3.

<b>Anglers</b>	<b>Surplus at current catch rate (€ per year)</b>	<b>Surplus at improved catch rate (€ per year)</b>	<b>Surplus difference (€ per year)</b>
All respondents	1774.06	2830.38	1056.32
Respondents living in the city of Venice and the islands of the Lagoon (ZONA=1)	3043.61	4422.82	1379.21
Respondents living in other areas (ZONA=2, 3, or 4)	769.29	1514.59	745.30

**Figures**

Figure 1



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(lxv) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications” organised by Fondazione Eni Enrico Mattei and sponsored by the EU, Milan, September 25-27, 2003

(lxvi) This paper has been presented at the 4th BioEcon Workshop on “Economic Analysis of Policies for Biodiversity Conservation” organised on behalf of the BIOECON Network by Fondazione Eni Enrico Mattei, Venice International University (VIU) and University College London (UCL) , Venice, August 28-29, 2003

(lxvii) This paper has been presented at the international conference on “Tourism and Sustainable Economic Development – Macro and Micro Economic Issues” jointly organised by CRENoS (Università di Cagliari e Sassari, Italy) and Fondazione Eni Enrico Mattei, and supported by the World Bank, Sardinia, September 19-20, 2003

(lxviii) This paper was presented at the ENGIME Workshop on “Governance and Policies in Multicultural Cities”, Rome, June 5-6, 2003

(lxix) This paper was presented at the Fourth EEP Plenary Workshop and EEP Conference “The Future of Climate Policy”, Cagliari, Italy, 27-28 March 2003

(lxx) This paper was presented at the 9<sup>th</sup> Coalition Theory Workshop on "Collective Decisions and Institutional Design" organised by the Universitat Autònoma de Barcelona and held in Barcelona, Spain, January 30-31, 2004

(lxxi) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications”, organised by Fondazione Eni Enrico Mattei and Consip and sponsored by the EU, Rome, September 23-25, 2004

(lxxii) This paper was presented at the 10<sup>th</sup> Coalition Theory Network Workshop held in Paris, France on 28-29 January 2005 and organised by EUREQua.

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