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Demand for Recreational Fishing in Tampa Bay, Florida: A Random Utility Approach

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Abstract *An estimation of demand for recreational fishing in Tampa Bay, Florida, can facilitate the environmental management of the bay. A nested random utility travel cost model is used to estimate access values. Results suggest that average annual values for the bay alone are $18.14 and $0.048 for participants and nonparticipants, respectively.*

Key words Nonparticipation, random utility model, recreational, travel cost method.

Introduction

Tampa Bay is one of Florida's primary fishing destinations, providing anglers with redfish, trout, grouper and many other popular recreational target species. It is an important recreational site for the estimated 496,435 anglers (1991) that live in the region (Milon and Thunberg 1993). Almost completely surrounded by urban areas, with 2,481,172 people clustered in ten counties, the Bay faces several environmental problems. One such problem was highlighted by a recent incident in which about 328,000 barrels of oil were spilled into the Bay, potentially harming fish and their habitats. The development of environmental standards for the urban areas that surround the Bay may eliminate similar problems. Thus, knowledge of recreational value of fishing in the Bay may be helpful in developing such standards, in particular, and in managing the Bay, in general.

A fundamental problem arises when estimating demand for recreational fishing because often the participant does not pay for access to the fishing site. The travel cost method (TCM) uses travel costs to the site as a proxy for the cost incurred by the participant for the fishing experience, and recent developments in TCM theory have led to increased usage of random utility models (RUMs) in addition to the original, continuous models. The superior ability of RUMs to depict a recreationist's decision-making process is a primary reason for the models' increased popularity. One disadvantage of the RUM, however, is that it is still difficult to account for nonparticipants in the context of its framework. As with traditional recreational demand models, RUMs may suffer because data is collected on-site, and the analysis may underestimate demand by excluding those who might choose to participate if the site were improved and those who

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value the option to fish at some future point in time (Bockstael, McConnell, and Strand 1991; Fletcher, Adamowicz, and Graham-Tomasi 1987; Freeman 1979).

In this study a nested multinomial logit RUM is used to estimate the economic value of recreational fishing in Tampa Bay. Because the first decision that a resident of the larger Tampa Bay region makes is whether or not to fish—the participation decision (Haab and McConnell 1996; Hellerstein 1992)—the first node of the RUM will be this choice. The hypothesized subsequent decision an angler makes will be the decision whether to fish in Tampa Bay or at an alternative site. While recreationists are the most obvious group to benefit from access to a recreation site, the whole community, including those who might fish in the future, will be included in this study to facilitate more complete valuation of the recreation site.

This work follows participation models, such as the one used by Morey, Rowe, and Watson (1993) that employed a Poisson-based, repeated, nested logit to model site choice for Atlantic Salmon fishing. The model was then estimated by considering that all anglers who did not go fishing during the particular time period had made a choice not to participate. Using this approach, the decision not to participate is made by those who are still regular participants. The current study instead uses information from a wide variety of nonparticipants, including those who had fished within the previous year, but not within the previous two months; those who had not fished in the previous year, but had fished previously; and those who had never fished at all. A good discussion of the heterogeneity of nonparticipants and its significance on participation may be found in Jackson and Dunn (1988) and in Wright and Goodale (1991).

Theoretical Considerations

Much has been written about the use of TCMs and RUMs in modeling demand and estimate values for recreation. Bockstael, McConnell, and Strand's (1991) discussion of recreation and Freeman's (1995) review of recreational fishing demand studies are two examples of the many excellent reviews that have been written. The simplest individual-based TCM models regress the number of visits to a site against travel costs to that site and demographic variables associated with an individual, such as age, employment status, years of fishing experience, etc. Some major issues in the empirical estimation are the inclusion of substitute sites, measures of fishing quality, and consideration of the costs of travel time.

The need to include substitute prices in TCMs follows market demand theory. If travel costs are analogous to prices, then travel costs to other sites will affect the site choice decision, and bias is likely to occur in welfare estimates if relevant substitutes are omitted (Rosenthal 1987).

In recreational fishing, a catch rate (CR) is often used as a measure of site quality. One way to estimate the CR is by computing the average number of fish caught by all anglers who catch a particular species (or species group); a multispecies CR includes all species in one measure. Such a CR does not specifically accommodate target species preferences and in this sense does not reflect the actual number of fish that a particular angler might expect to catch (Bockstael, McConnell, and Strand 1991). Huppert (1989) argues convincingly, however, that the outcome of a fishing trip is a function of both site attributes and angler attributes; therefore, a composite CR could average out differences across angler attributes, leaving an estimate of the differences in desirable fish populations across sites.

A measure of travel time is usually included with other travel costs because travel time in addition to travel costs may affect the site choice decision. Specification of the travel time parameter, however, has been shown to be the source of considerable variation in benefit estimation (Bockstael, Strand, and Hanemann 1987).

Random Utility Models

Developments in discrete choice models or RUMs have provided hope for the resolution of some issues in travel cost modeling. The RUM recognizes the recreationist's decision to visit a particular site as opposed to other competing or substitute sites as a stochastic, utility-maximizing choice. By theoretically incorporating the substitute sites, these models can avoid the multicollinearity difficulties associated with substitute sites that often characterize continuous models.

The RUM describes a choice occasion in which person i has a set of alternative sites from which to choose. The utility provided from a visit to site j is described by the indirect utility function, $V_{ij} = V(q_{ij}, z_i)$, where q_{ij} is a vector of characteristics of site j, including the travel costs to the site, as perceived by person i and z_i is a vector of person i's characteristics. Person i will then visit site j if the utility of site j is greater than the utility of all other sites k, where $k = (1, 2, \ldots, j, \ldots, n)$ is the set of all other sites in the choice set.

The utility of the choice is considered the sum of two parts, observable (V_{ij}) and unobservable (e_{ij}):

$$U_{ij} = V(q_{ij}, z_i) + e_{ij}. \tag{1}$$

The most common mathematical representation of the RUM is the multinomial logit (MNL), which assumes that e_{ij} is independent and identically distributed as a type I extreme value variate. The probability, p_{ij}, that individual i chooses site j out of n sites is expressed by

$$p_{ij} = \exp(V_{ij}) / \sum_{j=1}^{n} \exp(V_{ij}) \tag{2}$$

where exp $(\cdot)$ signifies the antilog function.

The MNL model's disadvantage lies in its assumption of the independence of an irrelevant alternative (IIA). All alternatives must have similar levels of substitutability between them for the model to be appropriate. This assumption requirement is often explained using an example of the commuter's decision. In order to get to work, the commuter must choose between the following alternatives: walking, driving, taking the train, or taking the bus. The problem with the MNL model is that, if an irrelevant alternative is added to the choice set, for example, taking a red bus and taking a blue bus, the model will be inappropriate.

The nested multinomial logit (NMNL) was developed by Domencich and McFadden (1975) and has successfully been applied to recreation by Milon (1988); Bockstael, McConnell, and Strand (1989); Morey, Rowe, and Watson (1993); and others. The nested logit model allows for the estimation of a series of decisions through the formation of a decision tree. Each tree branch, called a node, represents a set of alternatives with equal levels of substitutability. In this way, the IIA property is not as constraining.

The Nested Logit

Consider that decision B is conditional on decision A. For example, a resident first decides whether or not to go fishing (decision A), and then, if the answer to decision A was yes, decides where to go (decision B). An individual will use a utility, U_{kj}, for his/her choice between decision A = k and decision B = j (Maddala 1983). This utility is a function of the attributes of the choices and the attributes of the individual.

McFadden (1978) showed that, like the multinomial logit, the NMNL is consistent with utility maximization theory. While the multinomial logit assumes that the residuals of the random utility choice model are independent and identically distributed with a type I extreme-value distribution, the NMNL assumes the residuals are distributed with a generalized extreme value (GEV), thus allowing for some dependence between the choices and eliminating the IIA property. The probability, P_{kj}, that an individual will choose decision A = k (k = 1, …, n) and decision B = j (j = 1, …, m) is expressed by

$$P_{kj} = \exp(V_{kj}) / \sum_{k=1}^{n} \sum_{j=1}^{m} \exp(V_{kj}). \tag{3}$$

Now suppose that $V_{kj} = \beta' X_{kj} + \alpha' Y_k$, where X_{kj} is the vector of variables that varies with decision B, Y_k is the vector of variables that varies with decision A and α and β are vectors of unknown parameters. According to Greene (1987), the probability theory states that $P_{ij} = P_{j|i} * P_i$, and so the following can be calculated:

$$P_{j|k} = \exp(\beta' X_{k|j}) / \sum_{j=1}^{m} \exp(\beta' X_{j|k}) \tag{4}$$

and

$$P_k = \exp(\alpha_k' Y_k + \tau_k * I_k) / \sum_{k=1}^{n} \exp(\alpha_k' Y_k + \tau_k * I_k) \tag{5}$$

where

$$I_k = \log \sum_{j=1}^{m} \exp(\beta' X_{j|k}). \tag{6}$$

The probability expression can then be written as

$$P_{kj} = P_{j|k} * P_k = \frac{\exp(\beta' X_{j|k})}{\sum_{j=1}^{m} \exp(\beta' X_{j|k})} * \frac{\exp(\alpha' Y_k + \tau * I_k)}{\sum_{k=1}^{3} \exp(\alpha' Y_k + \tau_k * I_k)}. \tag{7}$$

Quantity I_k is called the inclusive value because it can be interpreted as a measure of the value, or expected worth, of a set of choice alternatives (Ben-Akiva and Lerman 1985). In the case above, I_k represents the expected utility of the collection of sites available to an angler. The coefficient on the inclusive value (τ) can be interpreted as an estimate of the similarity of the observed choices. If τ = 1, then the model collapses to a joint logit, or a multinomial logit, which would not employ the nesting structure but would instead model the $n \times m$ different combinations of decisions as equal choices. If the coefficient is not 1 and is still within the unit interval, this suggests the IIA property does not hold, and the nested model is appropriate. If the coefficient is not 1 and lies outside the unit interval, this may suggest other specification errors (Maddala 1983; Kling and Thomson 1996).

One recent example of an RUM used to model recreational fishing is found in Bockstael, McConnell, and Strand (1989). The authors use a NMNL to value marine recreational fishing on Florida's east coast. They discuss strengths and weaknesses of the RUM in the context of sport-fishing benefit estimates. They model the decision to fish at a particular site as conditional on a preliminary mode/species node, and they mention concerns about limiting the sample to participants only.

Empirical Specification

Data for this project were drawn from a study conducted by the University of Florida. The Marine Recreational Fishing Statistics Survey (MRFSS), a nationwide survey conducted annually by the National Marine Fisheries Service (NMFS), was a component of the study. The Florida study added questions to the MRFSS telephone survey about the number of fishing trips taken by the interviewee in the past two months, the trip site and the respondent's residence. During the period from July 1991 to June 1992, additional information about target species and trip mileage was collected for the University of Florida. A subset, consisting of 4,206 anglers of the 10,743 who answered the additional trip and species selection questions, was further interviewed by phone about its recreational preferences, backgrounds, and past fishing experiences. This same interview, the UF participation survey, was also administered to 2,024 of the households who had not fished in the two months prior to the telephone call. A subsequent mail survey—which included questions about expenditures on a typical fishing trip, species preferences, motivations, and attitudes toward management—was returned by 2,349 of the anglers.

The geographical region used in the current study is based on a survey described in Milon and Thunberg (1993) in which the state of Florida was divided into seven regions. The Tampa Bay region, one of the seven, includes five inland counties and five coastal counties. The collection of sites proposed as a substitute set are the coastal counties of Pinellas, Hillsborough, Manatee, Sarasota, and Pasco (figure 1). The regions were delineated according to major estuarine areas and adjacent population centers. Snook, redfish, trout, and grouper are common targets in the region. The Tampa Bay region is also part of a larger southwestern region used by Florida Marine Fisheries Commission for management purposes.

A total of 765 residents of the Tampa Bay region was used in this study. Of these, 765,389 had not fished during the two months prior to their telephone interviews. This group included those who had fished in the past year (but not in the two months prior to the interview) and those who had not. This group will be referred to as nonparticipants. An additional 376 anglers, who completed the telephone interviews and the mail surveys, had participated in saltwater fishing sometime during the two months prior to the first telephone interview. These individuals will be referred to as participants.

Weights for this data set were developed by Milon and Thunberg (1993) in their angler participation model. Each observation is weighted according to the number of households actually represented by the observation, based on the NMFS sample of fishing and nonfishing households. For example, Milon and Thunberg estimated a participation rate of 18.5% for the Tampa Bay region. The weights compensate for the fact that each nonparticipant observation represents more resident households than each participant observation does.

Figure 1. Counties in the Tampa Bay Region

Arguments of the Utility Functions

The proposed model will provide estimates of the probability that individual *i* visits site *j* as a function of travel costs (TC) to all sites, demographic variables of individual *i* (D_i) and characteristics of site $j(Q_j)$:

$$P_{ij} = f(TC_{ij}, D_i, Q_j). \tag{8}$$

For purposes of this research, CRs will be used as a measure of quality. The CRs used are based on the MRFSS data compiled in 1988–90. They can be considered estimates of what an angler expects to catch. The values used are the average total number of fish that interviewed anglers claimed to have caught on typical one-day trips. These values were averaged for the three years prior to 1991. Table 1 shows the estimated CR for the five different sites.

Travel costs in this study are based on an estimated cost per mile for the distance driven to the site. Anglers reported the distances to the sites in their telephone interviews. A computer program called AUTOMAP approximated the distances to the alternative (substitute) counties based on the zip codes provided by the angler.

Table 1
Catch Rates by County

Site	Catch Rate	Standard Error
Pasco	10.43	18.49
Pinellas	9.02	24.41
Hillsborough	9.41	30.55
Manatee	13.87	32.24
Sarasota	8.40	25.04

Total distance was then multiplied by $0.37, yielding the estimated cost of fuel and maintenance for the vehicle. This value can be considered the cost, or the price, of taking the recreational trip.

As a result of incomplete data on travel time and theoretical difficulty with the use of such measurements, only travel costs are used in this study. When considering welfare measures, the results of this study can be considered as a lower bound on values if one considers the opportunity cost of time to be positive. If the utility gained in the time spent driving to the sight is positive (for example, a particularly scenic drive), these measures would be an upper bound.

Because some observations in the data set had some missing values, efforts were made to impute values for some of the variables. For example, if the income variable was missing, the median value for the county of residence for that individual was used. Since many of the variables reflected preferences that could not be easily computed, however, some such incomplete observations were excluded. Because those observations with missing data might not be evenly distributed across the population, it is possible that the analysis results are not representative of the original data as reflected in Milon and Thunberg (1993). The final data set used includes 279 nonparticipants, plus the 1,834 trips taken by 311 participants. For more information regarding the sampling methodology used in the study, see Milon and Thunberg (1993).

Names and explanations of the variables to be used are presented in table 2. The variables, *LEISURE*, *OWN*, *INCOME*, *SEX*, and *CHILD*, were taken from the UF participation survey, and they apply to all residents. Average values of the variables are shown in table 3. The variables *TCOST* and *CATCH* are the travel costs and CRs relevant to the particular sites.

Table 2
Definitions of Explanatory Variables

Variable	Explanation
CATCH	Overall catch rate for the county, based on MRFSS data.
CHILD	Dummy variable for whether or not the angler fished as a child.
INCOME	Income group from 1 (less than $25,000/year) to 4 (more than $75,000/year).
LEISURE	Self-description of person: 1) very active, outdoors type; 2) somewhat active, outdoors type; or 3) prefers indoor leisure activity.
OWN	Dummy variable for boat ownership.
SEX	Dummy variable for gender.
TCOST	Approximate cost of travel ($.37 times the number of miles to the site).
PASCO	Pasco County.
PINELLAS	Pinellas County minus Tampa Bay anglers.
HILLS	Hillsborough County plus Bay anglers originating in Pinellas County.
MAN	Manatee County.
SARA	Sarasota County.

Table 3
Summary Statistics: Comparison Between Participants and Nonparticipants

Statistic	All Data	Participants	Nonparticipants
Number of Observations	765	376	389
Sex			
Male	45.6%	79.1%	42.3%
Female	54.4%	20.9%	57.7%
Fished as a Child			
No	37.1%	12.7%	39.5%
Yes	62.9%	87.3%	60.5%
Leisure			
Active	39.0%	63.1%	36.6%
Somewhat active	40.1%	33.3%	40.8%
Prefers indoor	20.9%	3.7%	22.6%
Income			
Under $25,000	40.6%	22.5%	42.4%
$25 – $49,999	36.5%	44.0%	35.7%
$50 – $74,999	15.1%	20.9%	14.5%
Over $75,000	7.8%	12.6%	7.3%
Boat Ownership			
No	78.0%	37.4%	82.0%
Yes	22.0%	62.6%	18.0%

Percentages may not add up to 100% due to rounding error.

Because the study's focus is an assessment of the value of Tampa Bay recreational fishing, anglers who fish from the east coast of Pinellas County will be coded with a destination of Hillsborough County. This way all of the angling in Tampa Bay will be coded with a site of HILLS.

Referring back to equations (4) through (7), the model can be represented by two equations that are both incorporated into a single equation used to measure welfare changes. First, let IS represent the inclusive value for the lower decision level (site choice). The inclusive value is an argument of the utility function of the higher decision level, and its associated parameter (τ) is estimated as

$$IS = \log\left(\sum_{j=1}^{5} e^{(\beta_0 * TCOST_j + \beta_1 * CATCH)}\right). \tag{9}$$

The equation of the participants' and nonparticipants' utility functions is:

$$V_{part} = (\tau) * IS + e_{part} \tag{10}$$

and

$$V_{nonpart} = \beta_{15} + \beta_{16} * CHILD + \beta_{17} * OWN + \beta_{18} * INCOME + \beta_{19} * SEX + \beta_{20} * LEISURE. \tag{11}$$

Welfare Measurement

The calculation of welfare benefits for the NMNL model follows a pattern based on the work of Small and Rosen (1982). The formula for the compensating variation is

$$CV = -\frac{1}{\beta_1}\left[\ln \sum_{j=1}^{n} \exp^{V_j^0} - \ln \sum_{j=1}^{n} n \exp^{V_j^1}\right] \qquad (12)$$

where β_1 is the parameter for travel cost representing the marginal value of money and V^0 and V^1 represent the utility function before and after the proposed change. The only relevant choices in this analysis are the two choices of participation and nonparticipation because the inclusive value of the participants' utility function already contains the estimated total value of the collection of five different lower-level options. For purposes of this study, the proposed welfare change regards access to Tampa Bay as a recreational fishing location. To assess the value of access, the change in welfare is estimated by calculating equation (12), first with and without HILLS in the choice set and then with and without both HILLS and PINE in the choice set. Figure 2 depicts the decision structure that is estimated in the model.

Results

Estimation results are presented in table 4. These results reflect the expected negative sign on the travel-cost parameter at a significance level of 99%. *CHILD* is also significant and of the expected sign as are *OWN* and *SEX*. The significance level of *LEISURE* suggests that this variable plays an important predictive role—that those who consider themselves more active, outdoors-type people are more likely to fish.

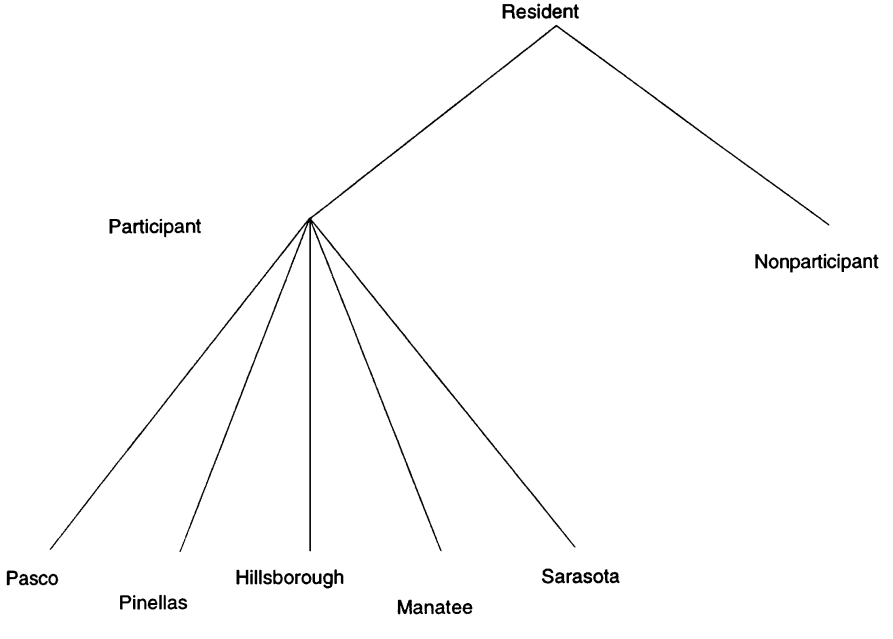

Figure 2. Decision Tree for Tampa Bay Resident

Table 4
Results from Estimation of Nested Random Utility Model

Variable	Parameter	Standard Deviation	Significance
TCOST	–0.404	(0.013[a])	***
CATCH	0.038	(0.028)	**
CONST - PART	3.797	(0.137)	***
CHILD	–1.287	(0.160)	***
OWN	–1.547	(0.108)	***
INCOME	0.040	(0.079)	—
SEX	–1.05	(0.162)	***
LEISURE	–0.933	(0.109)	***
PARTICIPATE - INCL. VALUE	0.5138	(0.038)	***
R^2	0.771		

Notes: ** and *** denote significance at the 95% and 99% confidence levels, respectively.
[a] Standard errors are presented in parentheses.

A modified R^2 value derived from maximum likelihood ratios has been used (Ben-Akiva and Lerman 1985) as well as the ratio of correctly predicted choices to observed choices (Horowitz 1985) in assessing the effectiveness of the model. Both measures were recently used by Ndoh, Pitfield, and Caves (1990) to test several models of air-travel route choices.

The proportion of choices predicted accurately is 85.2%, reflecting a high level of accuracy. It should be noted, however, that of the 14.8% of choices that were inaccurately predicted, 9.8% were cases where the model inaccurately predicted nonparticipation. The modified R^2 value is 0.771.

Welfare Benefits

Using equation (12), average values of welfare losses per angler were calculated at $1.68 per trip for the loss of the Bay itself and $3.66 for the loss of both the Bay and Pinellas County together. This overall average weighs each observation according to a weighting scheme developed with the data. This value can be multiplied by the average number of trips taken per angler per year to achieve an average value per angler per year. Using a much larger sample size (1,148), Milon and Thunberg (1993) calculated an average number of 10.8 trips per angler per year for the region. This reflects an annual value of $18.14 per angler for loss of access to Tampa Bay and a value of $39.53 for loss of both Tampa Bay and Pinellas County.

The value for the nonparticipant is $0.008, or eight-tenths of a cent, for the first scenario and $0.066 for the second. These values reflect the fact that Tampa Bay has some recreational fishing value even for nonparticipants. These values can best be considered as the loss of potential access value to the average nonangler. Sometimes such a value is known as an option value because it represents the value of the option to go fishing even if the resident does not choose that option (Barbier 1994).

Since the data was collected in two-month periods and the decision not to participate was made in a two-month period, it is suggested that the $0.008 value be counted six times per year. This adjustment would raise the estimated annual value to the nonangler to $0.048, or $0.396, for the respective scenarios.

The per-angler, per-trip values of $1.68 and $3.66 can be compared with values ranging from $0.97 for Brevard County, Florida, to $39.11 for a North Carolina coastal site (Freeman 1995). This range includes only the travel cost-based models used to estimate values for multispecies fisheries on the Atlantic and Gulf coasts. In this study, Freeman (1995) points out that the wide range of values is striking and is only somewhat explained by factors such as availability of substitutes (the more substitutes, the lower the values for a particular site), the definition of the population for sampling and analysis, and of course, differences in the quality of the experience. Freeman also suggests that the definition of the site is very important in benefit estimation. Because of these differences in substitutes, site definition and geography, the fact that the results of this study are particular to Tampa Bay and the surrounding region must be emphasized. This study considers two scenarios: (1) the loss of access to Tampa Bay, and (2) the loss of access to both the Bay and the Pinellas county Gulf coastline. Values are small because this study assumes that access to the substitute sites of Manatee, Sarasota, and Pasco is maintained. These scenarios would not, for example, be particularly appropriate when considering what recreational fishing value is lost under general habitat degradation unless the degradation was concentrated in one area and did not affect fish populations in the neighboring counties. Values for loss of access to the entire region would presumably be much higher as anglers would have to spend much more to travel to substitute regions.

Concluding Remarks

The values of access at $18.14 per angler per year and $39.52 per angler per year, with the estimated number of anglers in the region, suggest a value of $8,335,710 per year value for loss of access to Tampa Bay and $18,163,946 per year for the loss of access to both Tampa Bay and the west coast of Pinellas County. This value compares with a regional average total earned income for the years 1991 and 1992 in the region of $34.94 billion (*Florida Statistical Abstract* 1994). The value may be maintained as an indicator for the variety of planning, management, and damage considerations that may arise. In general, these results should be considered a lower bound on angler values for Tampa Bay because this specification excludes the cost of travel time spent. Because much of the travel is through an urban area, it is reasonable to assess travel time as a cost, not a benefit, to the angler.

The estimated value for nonparticipants ($0.048 per year for Tampa Bay and $0.396 per year for both Tampa Bay and Pinellas County) may seem insignificant in comparison to the value for active fishermen. But, when extrapolated across the large number of nonparticipants, the total estimated value is $95,507 per year for Tampa Bay alone and $787,935 per year for both. This method does, however, account for nonparticipant values in a theoretically consistent way and thereby includes those values where other models have not. Future research in this area might consider a variety of particular recreational activities and compare their values. Option values for, say, a charter boat, big-game fishing expedition might be much higher since more people who would not ordinarily choose to participate in such a trip in any given year might entertain thoughts of one day taking such a trip.

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