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Valuing snorkeling visits to the Florida Keys with stated and revealed preference models

Timothy Park*†, J. M. Bowker‡ and Vernon R. Leeworthy§

† *313C Conner Hall, Department of Agricultural and Applied Economics, University of Georgia, Athens, GA 30602-7509, USA*
‡ *Outdoor Recreation and Wilderness Assessment Group, Southern Forest Research Station, USDA—Forest Service, Athens, GA 30602, USA*
§ *Strategic Environmental Assessments Division, National Oceanic and Atmospheric Administration, US Department of Commerce, Silver Spring, MD 20910, USA*

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Coastal coral reefs, especially in the Florida Keys, are declining at a disturbing rate. Marine ecologists and reef scientists have emphasized the importance of establishing nonmarket values of coral reefs to assess the cost effectiveness of coral reef management and remediation programs. The purpose of this paper is to develop a travel cost—contingent valuation model of demand for trips to the Florida Keys focusing on willingness to pay (WTP) to preserve the current water quality and health of the coral reefs. The stated and revealed preference models allow the marginal valuation of recreationists to adjust depending on current and planned trip commitments in valuing nonmarginal policy changes in recreational opportunities. The integrated model incorporates key factors for establishing baseline amenity values for tourist dive sites, including perceptions of reef quality and dive conditions, the role of substitute sites, and the quality and availability of tourist facilities and recreation opportunities. The travel cost and WTP model differ in identifying critical variables and provide insight into the adjustment of trip decisions across alternative destination sites and the valuation of trips. In contrast to the travel cost model, a measure of the availability of substitute sites and total recreation activities does not have a significant impact on WTP valuations reported by snorkelers. Snorkelers engage in a relatively focused set of activities, suggesting that these recreationists may not shift expenditures to other sites or other recreation activities in the Florida Keys when confronted with increased access costs for the snorkeling experience.
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Introduction

Coastal coral reefs, especially in the Florida Keys are declining at a disturbing rate, highlighting concerns that coral reefs in all the tropical seas are threatened by degraded ecological conditions originating locally, regionally, and from distant continents. The rate at which coral reefs in the Florida Bay are disappearing is characterized as 'stunning' by ecologists, with some portions projected to disappear within 10 to 25 years (*The New York Times*, 1994). Dustan (1999) noted that coral reefs are the most complex and productive ecosystems in the sea and may prove to be 'the fragile harbinger of change warning us of declining oceanic health'. As a result, reef scientists have emphasized the importance of establishing nonmarket values of coral reefs to assess the cost effectiveness of coral reef management and remediation programs.

In an international context the value of coral reefs in terms of biological wealth along with the economic and environmental services they provide was noted in *Reefs at Risk* (Bryant *et al.*, 1998).

* Corresponding author. E-mail: tpark@agecon.uga.edu

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Tourism is an emerging and fast growing industry throughout the global economy and coral reefs are a major attraction for snorkelers, scuba divers, recreational fishers, and beach vacationers. The *Reefs at Risk* report noted that more than 100 countries benefit from the recreational values associated with reefs. Across the globe nearly half a billion people are located within 100 km of a coral reef and benefit from the production and protection of this aquatic ecosystem. The coral reefs of Southeast Asia face the most severe threats yet are also the most species-rich reef ecosystems. The *Reefs at Risk* report calculates that more than 80 percent of these reefs are under high or medium risk, primarily due to coastal development or fishing-related pressures.

The US Congress recognized the degradation of the Florida Keys ecosystem due to direct physical impacts and indirect impacts and passed the Florida Keys National Marine Sanctuary and Protection Act (FKNMSPA) of 1990. The Act requires the National Oceanic and Atmospheric Administration (NOAA) to develop a comprehensive management plan to govern the overall management of the Sanctuary and to protect the Sanctuary resources and amenities. A primary objective of the FKNMSPA was to provide a management system which is in harmony with an environment whose long-term ecological, economic, and sociological principles are understood while allowing appropriate sustainable uses.

The Florida Keys National Marine Sanctuary, extending approximately 220 miles southwest from the southern tip of the Florida peninsula, consists of approximately 2800 nm^2 of coastal and oceanic waters, and the submerged lands, surrounding the Florida Keys, and extending westward to encompass the Dry Tortugas, but excluding the Dry Tortugas National Park. Within these waters are spectacular, unique, and nationally significant marine environments, including seagrass meadows, mangrove islands, and extensive living coral reefs. These marine environments support rich biological communities possessing extensive conservation, recreational, commercial, ecological, historical, research, educational, and aesthetic values that give this area special national significance. Reef ecologists view these environments as the marine equivalent of tropical rain forests in that they support high levels of biological diversity, are fragile and easily susceptible to damage from human activities, and possess high value if properly conserved.

The economy of the Florida Keys is also dependent upon a healthy ecosystem. Over three million tourists visit the Keys annually, participating primarily in water-related sports such as fishing, diving, boating, and other ecotourism activities. In 1991, the gross earnings of the Florida Keys and Monroe County totaled $853 million, over 54 percent of which came from services provided as part of the tourism industry or related retail trade.

In March 2000, the US government announced a long-term plan to save coral reefs, proposing that 20 percent of all coral reefs in American-controlled waters would become ecological preserves by 2010 (*The New York Times*, 2000). The designation would protect the coral reefs from pollution, fishing and any other activities that could harm the reefs. Tourism based on scuba diving is the economic service of greatest importance to reef-based economies, suggesting that maintenance of sustained reef tourism is a central element in the justification of marine protected areas (Pendleton, 1994).

Davis and Tisdell (1996) noted the importance of developing models to establish baseline amenity values for tourist sites such as dive sites. Factors such as a diver's perceptions of reef quality and dive conditions, the role of substitute sites, and the quality and availability of tourist facilities and recreation opportunities influence nonmarket valuations and choices of tourist sites and dive locations. The need for on-site surveys and applied valuation methods such as travel cost and contingent valuation models is highlighted by reviewing the *Reefs at Risk* report.

The emerging literature on combining stated and revealed preference techniques implicitly recognizes that contingent valuation (CV) and travel cost methods are complementary valuation techniques, which work together in applied benefit estimation scenarios. Models based on revealed preference and stated preference data are classified in two main modeling frameworks by Herriges *et al.* (1999), who also reference key research in this area. The survey data have been combined using both random utility models and continuous demand functions.

In pooling models, both the revealed preference and stated preference surveys have the same format: travel cost data on prices and quantities are pooled with contingent valuation data on prices and quantities and the same set of variables appear in each model. Econometric specifications can be based either on discrete choice models or continuous demand functions. Rosenberger and Loomis (1999) estimate a pooling model for travel visit decisions and contingent behavior trip decisions for valuing agricultural land as open space. A second framework develops combined models in which the SP data takes on a different format than the RP data.

For example, a travel cost model is combined with a dichotomous choice CV question which elicits 'yes' or 'no' responses.

The basic objective of both approaches is to validate or test the consistency of the SP data, assuming that the RP are true. An underlying goal of these studies is to use revealed preference data to anchor or benchmark the consistency and validity of the stated preference data. McConnell *et al.* (1999) state that joint estimation using RP and SP information can be used to calibrate SP valuation models. The underlying assumption is that the revealed preference data is true and the stated preference responses should be tested for consistency. The travel cost model is used as the framework for establishing whether the contingent valuation model is consistent with behavior. The information contained in the combined approaches also promotes more efficient estimates of empirical welfare measures.

An alternative research agenda recognizes that SP surveys contain different types of information than RP surveys and the information should be used to describe the preferences of respondents more accurately. McConnell *et al.* (1999) note that on-site surveys implicitly establish a lower bound on WTP by sampled respondents. The nature and location of the CV survey also provides information that should be incorporated into the decision model and econometric specification when using information from revealed preference and stated preference surveys. The timing of information gathered in administering the CV survey naturally occurs after the observed trip and provides another source for framing information about preferences.

Carson *et al.* (1990) emphasize the importance of accounting for current access and use conditions for nonmarket goods along with constraints and opportunities that affect valuation and participation decisions. Consumer willingness to pay for environmental goods and marginal valuations of these goods depends both on current use and future or expected participation patterns. For example, the willingness to pay for a fishing license may depend both on the number of fish permitted by the license and the individual's expected catch rate in the absence of any special license requirements. Our model uses information about current and observed trips from the travel cost model along with projected site visits to a recreation site elicited from the contingent valuation scenario. The basic objective is to incorporate information from the complementary survey methods to identify the key variables that affect current and future trip visits to the Florida Keys coral reefs.

The paper is organized in five sections. The second section outlines the travel cost model of demand for trips to the Florida Keys and the contingent valuation model examining willingness to pay (WTP) to preserve the current water quality and health of the coral reefs in the Florida Keys. The framework builds on Englin and Cameron's (1996) assessment that information about actual and observed trips should be used to anchor responses for nonmarket resource valuations. The third section deals with survey design, data and the econometric specifications for estimating travel cost and contingent valuation models. The fourth section presents and analyzes the results of the econometric models with interpretations focused on management implications for the Florida Keys. The fifth section concludes the paper and assesses the value of the nonmarket valuation models for interdisciplinary research issues in managing coastal and marine resources.

Models

The demand for natural resource based recreation visits to the Florida Keys/Key West area is derived from a travel cost model. The travel cost model based on utility maximization subject to budget and time constraints leads to the Marshallian demand function:

$$\text{TRIPS} = T(C_p, Y, X, A, \varepsilon) \qquad (1)$$

where TRIPS denotes the number of recreation trips, C_p is the per-person travel costs for each trip, Y is household income, X represents a vector of individual respondent characteristics, and A is a vector of site-specific trip attributes. Unobservable individual factors that influence recreation decisions are represented by ε and are incorporated into the error term in the econometric model.

Information for the travel cost model was supplemented with a contingent valuation survey examining WTP to preserve the current water quality and health of the coral reefs in the Florida Keys. Snorkelers identified the maximum amount in additional expenses they were willing to pay before they would cease visiting the Florida Keys over the next 12 months. Total expenses per visit for each individual included travel costs, hotel and campsite fees, and payments for food and drink. Respondents also indicated the number of trips they plan to take

under current water quality conditions over the next 12 months. Recreationists who engaged in snorkeling during the summer months and the winter months were sampled and matched with responses from the travel cost survey. The contingent valuation survey elicited ratings of current water quality and health of the coral reefs from the recreationists to establish a quality baseline for the diving site.

The valuation model begins with the utility function for on-site visitors. Visitors have incurred per-person trip expenses of C_p to enjoy the current level of environmental attributes and management practices for water quality and coral reef maintenance in the Florida Keys denoted as Q. In the contingent valuation scenario respondents define the additional trip expenses ΔC_p they would pay to continue visit the recreation site.

The utility function for snorkelers visiting the Florida Keys depends on both the current level of trips, TRIPS and projected trips under current quality conditions, TRIPS*. Individual respondent characteristics and trip attributes are also included in the econometric model. Carson *et al.* (1990) emphasize the importance of accounting for current access and use conditions for non-market goods along with constraints and opportunities that affect valuation and participation decisions.

Consumer WTP for environmental goods and marginal valuations of these goods depends both on current use and future or expected participation patterns. For example, the valuation of a fishing license may depend both on the number of fish permitted by the license and the individual's expected catch rate in the absence of any special license requirements. We use information about current trips from the travel cost model with future site visits provided by survey respondents prior to the contingent valuation assessment.

The utility function is expressed as

$$V_1 = V_1(Y - WTP, X, A, TRIPS, TRIPS^*) \quad (2)$$

where $WTP = C_p - \Delta C_p$ represents the compensated total WTP. Following Dobbs (1993) specification of the WTP measure forms the starting point for the econometric model and is implicitly defined from equation (1):

$$WTP = W(Y, X\ A, TRIPS, TRIPS^*, \mu) \quad (3)$$

Unobservable individual factors that influence recreation decisions under the current quality level are incorporated into the error term denoted by μ.

The utility function for snorkelers visiting the Florida Keys is conditioned on the difference between current trip demand, TRIPS and projected trips if current quality conditions are maintained, TRIPS*. A key factor influencing an individual's choices and valuation of the recreation experience is the level of planned participation. In the contingent valuation scenario respondents indicate the optimal number of trips they would make to the Florida Keys under current quality conditions. Information on the observed number of trips, TRIPS, is available from the travel cost survey and this information provides the linkage between observed valuation and the stated preference model. Recreationists who plan to increase trip visits to the Florida Keys represent respondents whose desired trips exceeds the number of observed recreation trips, or $[TRIPS^* - TRIPS] > 0$.

The specification of the WTP model examines how marginal valuations of the recreation experience vary between snorkelers who plan to increase Florida Keys visits and those who plan to maintain or decrease trips. Respondents may express a desire to take more trips but the key issue in valuation is to measure how WTP for additional trips adjusts with increased visits. The econometric model examines this issue using a spline function which allows WTP to vary depending on the level of current and planned trips to the Florida Keys.

Recreation managers and local commercial groups gather survey information and formulate projections about future visit levels to snorkeling sites in the Keys. The proposed model establishes a linkage between projected visits and the factors influencing the valuation placed on additional visits. The WTP model from the contingent valuation survey is designed to identify significant factors in trip valuations and to assess how marginal values are affected by site attributes and household characteristics. In the next section the variables used in the models are defined and survey methods are outlined. A summary of the descriptive statistics comparing the two groups is presented in the data section to motivate specification of the econometric model.

Survey design, data, and model development

A travel cost survey conducted by the National Oceanic and Atmospheric Administration (NOAA) working with the US Forest Service in conjunction with the University of Georgia's Environmental

Table 1. Description of variables in the travel cost and contingent valuation models

Variable	Definition
Dependent variables	
TRIPS	Annual number of person-trips to the Florida Keys/Key West for natural resource based activities
TOTWTP	Maximum acceptable willingness to pay: increase in per trip expenses plus incurred travel costs
Explanatory variables	
TC2PPTH	Travel cost per person-trip
DSUB1	Binary substitute variable (1 = would travel to alternative site, 0 = no alternative site)
YRKEYS	Number of years experience visiting the Florida Keys/Key West
ACTTOT	Number of recreational activities respondent participated in
WQREEF	Respondent's rating of current water quality and health of reefs (Range: 1 = poor to 7 = excellent)
AGEH	Age of person interviewed (years)
INC	Household income (in $1000)
TRIPS*	Desired number of trips elicited from contingent valuation scenario
CONSTR	Binary variable: = 1 if plans to increase trips = 0 if no plans to increase trips
SUMDUM	Binary variable for summer snorkeler
DTRIP	Average number of days per trip

and Resource Assessment Group and the Department of Agricultural and Applied Economics forms the framework of the modeling effort.[1] The on-site customer survey of residents and visitor use of the Florida Keys and Florida Bay during July–August 1995 and January–April 1996 comprises the full sample. A sample of respondents who participated in natural resource-based activities including all water-related activities and wildlife viewing and land-based nature study was generated. Leeworthy and Bowker (1997) have worked extensively with these datasets of 1608 summer season respondents and 2427 winter respondents involved in natural-resource based activities.

A subsample of these participants in natural-resource based activities (in both summer and winter seasons) also received contingent valuation questionnaires. The number of administered contingent valuation surveys was constrained by the project budget and contractual arrangements with the on-site interviewing group, Bicentennial Volunteers, Inc. However, the interviewers administered all surveys on-site directly to participants resulting in a response rate approaching one hundred percent.

The contingent valuation survey conducted during 1995 and 1996 has 460 complete responses for the WTP econometric model, with 154 snorkelers from the summer season and 328 winter snorkelers. The summer sample was restricted to the Key Largo area in the Upper Keys while the winter sample contained snorkelers throughout the Keys. The model is focused on snorkelers or recreationists who have participated in activities involving access to coral reefs. As the 460 respondents to the CV survey were also participants in natural resource-based activities, the travel cost model is also based on 460 respondents.

The contingent valuation survey included background information on cooperative efforts by Federal, state, and local agencies to protect the quality and natural resources of the Florida Keys and Florida Bay area. Respondents were informed that increases in resident and visitor populations would require expanded infrastructure investments to maintain, upgrade, and expand wastewater handling facilities and to ensure the health and viability of the coral reefs. The survey included a reminder of the budget constraint facing respondents by mentioning that the additional money devoted to protecting the water quality and health of the coral reef could be used to purchase other good and services.

Descriptive statistics reveal no major differences between the subsample of snorkelers drawn from visitors participating in natural resource based activities. Leeworthy and Wiley (1996a) also provide detailed profiles of the visitors and Leeworthy and Wiley (1996b) develop importance-satisfaction ratings for natural resource attributes, facilities, and services in the Florida Keys.

Table 1 provides definitions of all the variables used in the model. Following Bowker *et al.* (1996) the dependent variable is defined as a person-trip. A family of four visiting the Keys one time accounts for four person-trips as does an individual

[1] See the website http://www-orca.nos.noaa.gov/projects/econkeys/econkeys.html for survey information and design, project reports and background information.

visiting the Keys four different times in one year. Given the same origin points and travel modes, the price per person-trip would differ as the single visit cost for the family of four is apportioned to four person-trips. Leeworthy and Bowker (1997) suggest that this specification is appropriate for situations where group travel to the recreation site by automobile is as common as in the Florida Keys. Ward and Loomis (1986) note that this definition of recreation trips assists in mitigating the adverse impacts for model specification which can occur when the dependent variable takes on a limited range of values.

Travel costs are represented by the per person-trip costs scaled in hundreds of dollars. The calculated travel costs attempt to measure marginal cost of mileage as only a portion of the total mileage costs was assigned to trips where the Keys was not the primary destination of the trip. Calculation of the travel costs measure accounts for different modes of travel used in arriving at the Florida Keys. Mileage costs were equal to \$0·14 per mile for automobiles only and \$0·30 per mile for multiple modes of travel. The per mile costs were calculated using information obtained from an expenditure mail back survey component and are described in complete detail in Leeworthy and Wiley (1996a).

The sample used in estimating the travel cost demand model included visitors who participated in a diverse set of natural resource-based activities. Natural resource-based trips accounted for 72·5 percent of the total person-trips made to the Florida Keys/Key West by recreationists during the year June 1995–May 1996. To avoid biases associated with ignoring the role of site substitution as visitors consider alternative activities, a binary variable indicated whether the visitor would travel to an alternative site.

Reflecting the diverse recreation opportunities in the Florida Keys area, participation in thirteen different categories of recreation, leisure and cultural activities was recorded. The categories included activities related to snorkeling, scuba diving, fishing, nature viewing from boats and shore, beach recreation, sailing and boating, camping. Visits to nearby attractions such as historic areas, cultural events and festivals, museums, and sports events were also recorded. Recreationists who had previously visited the Keys may be more familiar with the availability of these activities and may more readily allocate time and expenditures to these activities. A variable for years of experience in visiting the Keys enters the travel cost model to account for this familiarity factor gained in previous visits to the Keys.

The level of actual participation in recreation activities is measured by the total number of activities in which the visitor participated during the trip. The extent of participation ranges from one to eight activities and accounts for the diversity of activities used by visitors to the Key West area. Over 98 percent of snorkelers participated in one to four alternative activities with beach visits, nature viewing from boats, and fishing each registering almost 25 percent of these visitors. The snorkelers are relatively focused in allocating time and expenditures across alternative recreation activities. Snorkelers did not choose to participate in more than 6 of the 13 activities and no snorkeler expressed interest in visiting cultural attractions, camping, or outdoor sports such as golf and tennis. Recreation managers, tourism and marketing planners, and local business enterprises may be interested in evaluating how a diverse set of recreation activities impacts economic values for trips to the Key West area.

A quality measure of the snorkeling visit was elicited by asking participants to rate the current water quality and health of the coral reefs in the Florida Keys. The rating was scaled between 1 and 7 with higher values indicating better perceived quality. Recognizing the need to systematically collect data on global reef health, the ReefCheck program also enlists recreational divers to assess reef conditions in a collaborative effort with scientists (Pennisi, 1997). Over 65 percent of snorkelers rated the water and reef quality as relatively poor, with a rating of three or below. The water quality ratings are not closely correlated with previous experience in Keys snorkeling activity or with activity participation measures. The valuation model examines whether the water quality and coral reef assessment measure influences WTP for the trip. Individual demographic and socioeconomic factors represented by age and household income are incorporated into the model.

The travel cost demand model uses participants in natural resource-based activities, including all water-related activities (except swimming in a pool) and viewing wildlife or other nature study from land. A truncated negative binomial regression model for trip demand is specified in general form as:

$$\ln(\mathrm{TRIPS}) = \beta_0 + \beta_1 C_p + \beta_2 X + \beta_3 A + \varepsilon \quad (4)$$

where ln(TRIPS) is the natural logarithm of the number of recreation trips, C is travel costs, X represents individual characteristics, and A is a set of site-specific and trip attributes. Regression

parameters are represented by β and $\exp(\varepsilon)$ is assumed to follow a gamma distribution with mean 1·0 and variance α (Greene, 1997). Seasonal dummy variables for summer and winter seasons are incorporated as site attributes to account for differences between visitors by season.

The empirical model derived from the contingent valuation survey recognizes that the respondent's true but unobserved maximum WTP depends on respondent characteristics and site-specific attributes. The dependent variable is the maximum acceptable WTP measured as increases in per trip expenses plus travel costs. Maximum acceptable WTP is truncated from below by travel costs incurred by each recreationist, resulting in a Tobit model with a lower bound that varies across respondents.

Each respondent's valuation for trips is anchored around the desired trips, TRIPS* which is elicited from the contingent valuation survey. To account for potential differences in trip valuation between respondents who indicate plans to increase the number of Florida Keys trips, the slope of the WTP model is allowed to vary across respondents. An indicator variable identifies avid Keys visitors who plan to increase visits over the next twelve months, where CONSTR = 1 when [TRIPS* − TRIPS] > 0. The WTP specification from equation (3) is:

$$\mathrm{WTP} = \gamma_0 + \gamma_1 \mathrm{Y} + \gamma_2 \mathrm{X} + \gamma_3 \mathrm{A} + \gamma_4 \mathrm{TRIPS} + \delta_1 \mathrm{CONSTR} + \delta_2 \mathrm{TRIPSxCONSTR} + \mu \quad (5)$$

Imposing the restriction that the WTP specification is continuous implies the linear restriction that $\delta_1 = -\delta_2 \mathrm{TRIPS}^*$:

$$\mathrm{WTP} = \gamma_0 + \gamma_1 \mathrm{Y} + \gamma_2 \mathrm{X} + \gamma_3 \mathrm{A} + \gamma_4 \mathrm{TRIPS} + \delta_2 \times [\mathrm{TRIPS} - \mathrm{TRIPS}^*] * \mathrm{CONSTR} + \mu \quad (6)$$

where the explanatory variables are identical to those defined in the travel cost model.

Summary statistics (mean, standard deviations) are presented for the key two groups discussed in the analysis: current visitors who plan to increase visits to the Florida Keys and those with no plans for increased visits (Table 2). Statistically significant differences in the variables across the groups are noted in bold. For convenience in discussing the

Table 2. Descriptive statistics: variables in the travel cost and contingent valuation models

Explanatory variable	No plans[a] to increase visits	Plans to increase visits
TRIPS		
Made 2 or fewer trips	56·8[b]	52·2
Made 3–5 trips	30·7	18·5
Made 5–10 trips	7·6	13·0
Made 10 or more trips	4·9	16·3
TOTWTP	**$563·07** (658·44)	**$359·44** (554·76)
TC2PPTH	**$206·94** (328·58)	**$112·29** (240·86)
DSUB1	**37·2**[b] (48·4)	**14·1** (35·0)
YRKEYS	**10·08** (10·67)	**12·73** (12·18)
ACTTOT		
In 2 or fewer activities	76·6[b]	78·3
In 3 or more activities	23·4	21·7
WQREEF	3·10 (1·46)	2·94 (1·17)
AGEH	**39·44** (12·30)	**34·13** (9·41)
INC	$640·08 (390·07)	$573·10 (439·86)
TRIPS*		
Plans 2 or fewer return trips	66·0[b]	16·3
Plans 3–5 return trips	27·5	25·0
Plans 5–10 return trips	3·5	30·4
Plans 10 or more return trips	3·0	28·3
SUMDUM	**26·9**[b] (44·4)	**39·1** (49·1)
DTRIP	**11·25** (24·50)	**3·58** (3·06)
Number of observations	368	92

[a] Mean values with standard deviations in parentheses. Significant differences noted in bold at the 10 percent level.
[b] Percentage of respondents in the category.

analysis, we define the recreationists who plan to increase future Florida Keys visits as avid recreationists. Avid recreationists typically take more trips under current conditions and have higher levels of desired trips than visitors with no plans to increase visits. The avid visitors desire to make an average of six trips compared with an average of about one trip for the visitors with no plans for additional visits.

Avid visitors have lower levels of incurred travel costs and register lower average WTP values. Visitors in this group are more familiar with recreation opportunities in the Keys, with about 12 years of experience in visits compared with 10 years of experience for the complementary group. Snorkelers in the group of avid visitors are more focused in their activities and participate in fewer total activities on average. These comparisons highlight differences in the observed valuation of the avid recreationists who plan to expand visits to the Keys and this information may be useful to state and local recreation managers and development planners. An important question is how the observed behavioral differences impact WTP values and this issue is evaluated in the econometric model.

Model estimation and results

The travel cost model for annual number of per-person trips and the contingent valuation model for WTP were estimated for snorkelers visiting the Florida Keys. We interpret the results from the travel cost model and the estimated welfare measures, comparing the results with previous research on the valuation of recreation visits to the Florida Keys. The implications of the WTP model are then discussed.

Travel cost model interpretation and welfare estimates

Table 3 shows results for the truncated negative binomial specification of the travel cost model. The distribution of the trips variable is examined for evidence of overdispersion in testing whether the conditional mean and variance of trips are equal given the explanatory variables in the model. The proportion of recreationists engaging in only one trip was 23·2 percent while 32·6 percent took two trips with a gradual decline in participants who commit to more than two trips. The sample mean of 4·79 trips along with a sample variance of 10·28 indicates substantial overdispersion in the number of trips. The hypothesis of no overdispersion was rejected based on the auxiliary regression tests proposed by Cameron and Trivedi (1990). The Lagrange Multiplier (LM) test statistics of 2·161 and 3·425 both exceed the 5 percent critical z-value. Marginal effects representing the effects of changes in the number of trips for a one unit change in a given factor are calculated as the mean number of trips multiplied by the estimated coefficient on that factor. Statistical significance for the price elasticity of demand measure is also noted and interpreted.

The coefficient for the travel cost measure is negative and statistically significant, confirming a downward-sloping demand curve. The demand

Table 3a. Count data estimates of travel cost model for Florida Keys visits

Explanatory variable	Coefficient estimate[a] (*t* ratio)
Constant	0·844* (7·768)
TC2PPTH	−0·208* (−7·070)
DSUB1	−0·635* (−3·432)
YRKEYS	0·033* (4·735)
ACTTOT	0·204* (2·935)
WQREEF	−0·014 (−0·318)
AGEH	0·017 (0·216)
INC	0·006 (3·316)
SUMDUM	0·769* (5·603)
DTRIP	−0·007 (−1·186)
Variance parameter α	1·270* (5·742)
Number of observations	460

[a] Asterisk indicates significance at the 10 percent level.

Table 3b. Tobit estimates of contingent valuation model for willingness to pay

Explanatory variable	Coefficient estimate[a] (*t* ratio)
Constant	3·092* (5·500)
DSUB1	−0·120 (−0·179)
YRKEYS	−0·119* (−4·042)
ACTTOT	−0·090 (−0·313)
WQREEF	−0·110 (−0·511)
AGEH	0·338 (1·138)
INC	0·264* (3·316)
TRIPS	−0·254* (−1·811)
[TRIPS − TRIPS*] × CONSTR	0·269 (1·333)
SUMDUM	−1·270* (−1·664)
DTRIP	0·038* (2·536)
Variance parameter σ	6·363* (28·764)
Number of observations	460

[a] Asterisk indicates significance at the 10 percent level.

elasticity from the model is −0·39 and aligns with reported estimates of the demand for snorkeling and for recreation visits to the Florida Keys. Leeworthy and Bowker (1997) estimated a price elasticity of −0·30 in a pooled model for all natural-resource based visits to the Florida Keys. Davis and Tisdell (1996) suggested that user permits or increased fees could be used to manage congestion or control the number of divers at a site. Demand elasticities for snorkeling and recreation visits are important in providing information to assess shifts in visitation patterns as fees and user permits are imposed.

The availability of alternative sites has a significant negative effect on number of trips, suggesting that visitors to the Florida Keys consider shifting travel plans and participation choices when information on amenities and recreation opportunities at alternative sites is made available. The number of years visiting the Florida Keys is a positive factor influencing demand for trips as each additional year of experience in visiting generates about 0·35 more trips. Decisions to visit the Keys for snorkeling are influenced by alternative recreation activities as indicated by the significant positive coefficient on the total activities variable. An increase in the diversity of available activities results in 0·34 extra trips. The total activities variable and years of experience have virtually identical impacts on the number of Keys trips as the elasticity estimates are not significantly different.

Trips by snorkelers to the Keys are not closely linked to household characteristics such as age and household income as the coefficients on these factors are not statistically significant. Leeworthy and Bowker (1997) indicated that age and household income do influence participation patterns for natural resource based trips and that these patterns differ across the winter and summer seasons. These relationships were not confirmed for the subsample of visitors who are interested in snorkeling vacations to the Florida Keys.

Nonmarket economic user values for per person-trips are evaluated from the estimated travel cost model. Following Bockstael and Strand (1987) the consumer surplus per trip from the semilogarithmic demand specification is $1/\beta_{tc}$, or one divided by the absolute value of the estimated travel cost coefficient. All welfare measures are reported on a per person-trip basis. The annual average per person user value for snorkeling trips was $481·15 from the truncated negative binomial model with a standard error of $68·06.

Leeworthy and Bowker (1997) reported an overall annual average value of $653·94 per person-trip which varied across summer and winter seasons. Summer visitors revealed trip values of $740·52 with winter trips at $561·19. The summer per person-trip values were higher than the winter season values, even though trips are significantly longer during the winter. The difference was largely attributed to the greater share of activity in water-related activities during the summer, especially snorkeling and scuba diving. Bhat (1999) estimated a user value of $1087 for a Florida Keys visit for diving, snorkeling, or participating in glass-bottom boat rides. Bhat conjectured that user values for underwater recreational activities would be higher than for other outdoor activities in the Keys but our results do not support this hypothesis. Our results suggest that mean user values for water-based activities such as snorkeling and scuba diving are about 35 percent lower than user values for a broader range of natural resource activities in the Florida Keys.

The consumer surplus per day for visitors who plan to increase visits above current levels is $207. This value is about 59 percent higher than for visitors with no plans for more visits. Recreation managers along with commercial service providers such as hotels, eating establishments, and other tourist services find these breakdowns useful in identifying and targeting visitors who indicate they will return for future visits. Tourists in this group place higher values on access to the Florida Keys.

A test that the impact of travel costs on visits was significantly different across summer and winter seasons was rejected. The Wald test statistic resulted in a value of 0·03 which did not exceed the χ^2_1 critical value of 3·84 at the 95 percent confidence level. The travel cost model shows no evidence that the demand elasticity for snorkeling visits to the Florida Keys varies across seasons. In turn, the estimates of trip values are not significantly different across the summer and winter seasons.

WTP model interpretation and implications

Maximum likelihood estimates for the WTP model are presented in Table 3 and the estimated coefficients are interpreted by both sign and statistical significance. The travel cost and WTP model differ in identifying critical variables, highlighting the insights provided in estimating both a travel cost and contingent valuation model and the survey design which evaluates observed trips and

contingent trip valuation decisions. The mean predicted WTP from the Tobit model was $735, which was 40 percent higher than the mean increase in per trip expenses plus incurred travel costs total recorded by the contingent valuation respondents. Over 85 percent of predicted WTP values were within a plus or minus $50 range of the total trip expenses from the contingent valuation scenario.

Years of experience in visiting the Keys has a significant negative impact on WTP while the travel cost model revealed that visitation experience to the Keys has a positive effect on the number trips. Recreationists who are familiar with the area may take more trips but the valuation model confirms that WTP for these trips declines. Expenditure patterns adjust as additional trips are planned, indicating the limitations of modeling approaches that predict trips and assume that current trip expenditures will be maintained without using information from an integrated valuation model.

A consistent result in both the travel cost and Tobit model is that ratings about current water quality and coral reef health by survey respondents were not statistically significant. One widely used method to collect data on the health and vitality of global reefs relies on recreational divers to assess reef conditions in conjunction with marine scientists. The *Reefs at Risk* report commented on the potential value of this information. For the Florida Keys recreationists, these results suggest that ratings are not closely correlated with values that visitors place on access to coral reefs.

In contrast to the travel cost model, the substitute sites measure and total recreation activities variables show no significant impacts on WTP valuations of snorkelers. Snorkelers engage in a relatively focused set of activities as confirmed in the participation indicators. The results suggest that these recreationists may not shift expenditures to other sites or other recreation activities in the Florida Keys when confronted with increased access costs for the snorkeling experience. The models provide insight into the adjustment of trip decisions across alternative destination sites and the valuation of those trips. Both elements are essential in evaluating program impacts associated with visits to the Florida Keys. The demographic variables related to age and household income do not have significant impacts on the total WTP for snorkeling, a result which is consistent with the travel cost model.

A critical issue in managing coral reef access is to assess how marginal values of the snorkeling experience depend on the recreationist's current and prospective number of trips. The contingent valuation scenario for snorkeling assesses how WTP adjusts as recreationists plan increased visits to the Florida Keys. The results of the Tobit model indicate that WTP for coral reefs trips declines as recreationists make additional trips. Dobbs (1993) noted that theoretically WTP for additional site visits will normally decline with increases in the number of trips. The issue of whether trip valuations to the Florida Keys coral reefs for avid, repeat visitors are significantly different from other visitors is addressed by allowing the slope of the WTP model to vary across these respondent groups. The slope of the WTP model for the avid, repeat visitors is not statistically significant as the coefficient on the interaction term from equation (7) indicates. Avid recreationists who plan to increase visits to the Florida Keys do not demonstrate significantly different WTP levels than visitors who have no plans for increased visits. These results highlight the difficulty recreation managers face in integrating survey information on trip intentions with trip valuation measures for access to environmental resources, such as snorkeling.

Confirmatory evidence from the survey provides some explanation for the result. The survey asked respondents to estimate trip costs for the most recent visit and were then asked whether the Florida Keys trip was worth the amount spent. These responses indicate whether visitors who felt the trip was worthwhile also plan higher levels of future visits. Twenty percent of those indicating that the trip was worth the amount spent plan to increase the number of trips over the next 12 months. But even recreationists who indicated a desire to decrease their trips to the Florida Keys had about the same satisfaction level (24 percent) in evaluating the worth of the trip. Survey responses about the overall value of the trip provide limited information about nonmarket values, a result consistent with the insignificant impact of trip intentions in the econometric results from the WTP model.

The consumer surplus per day for visitors who plan to increase visits above current levels is $207. This value is about 59 percent higher than for visitors with no plans for more visits. Recreation managers along with commercial service providers such as hotels, eating establishments, and other tourist services find more detailed breakdowns of WTP useful in identifying and targeting visitors who indicate they will return for future visits. Avid, repeat visit tourists place higher values on access to the Florida Keys.

Conclusions

Highlighting the crisis facing coral reefs, Risk (1999) commented on the inability of the scientific community to establish programs to monitor, evaluate and rededicate these resources. The techniques applied here may increase awareness among marine scientists and reef ecologists about the role of nonmarket valuation methods in assessing the economic importance of these resources. Sturgeon (1992) mentioned the key role of contingent valuation methods in developing measures of WTP for coral reef preservation. As reefs around the world face accelerating damage due to over exploitation and indirect human impacts, he noted that 'part of the problem stems from the fact that the full economic value of coral reefs is rarely appreciated' lending weight to the valuation methods applied here.

In addition, the United Nations foundation established by the philanthropist Ted Turner recently announced a $10 million grant to the International Coral Reef Action Network with the specific goal of promoting environmentally safe activities near reefs, including eco-friendly tourism activities. A United Nations Environment Program report (*Minneapolis Star Tribune*, 2001) stated that coral reefs are vanishing faster than expected and emphasized the importance of documenting the economic and social benefits associated with reefs. The economic models for valuing access to reefs can be used to evaluate management policies and recreational activities that promote tourism while maintaining coral reef quality.

Information from travel cost and on-site contingent valuation surveys is useful in evaluating nonmarginal policy changes in recreational opportunities and in extending the domain of the demand function beyond the observed data. In addition, the model allows the marginal valuations of recreationists to adjust depending on current and planned trip commitments. Extensions of the model should consider the role of other consumer attitudes in changing marginal valuations for recreational opportunities.

Both a travel cost model of demand for trips to the Florida Keys and a contingent valuation survey examining WTP to preserve the current water quality and health of the coral reefs in the Florida Keys are estimated. The models incorporate key factors for establishing baseline amenity values for tourist dive sites, including perceptions of reef quality and dive conditions, the role of substitute sites, and the quality and availability of tourist facilities and recreation opportunities. Estimation of the travel cost model recognizes that trips to the Florida Keys are measured as count data. The specific results from the travel cost model reveal that the per person-trip values for Florida Keys/Key West visits are consistent with previously reported estimates. The annual average per person-trip user value for snorkeling trips was $481·15 from the truncated negative binomial model with a standard error of $68·06.

A contingent valuation survey was used to elicit from snorkelers the maximum amount in additional expenses they were willing to pay before they would cease visiting the Florida Keys over the next 12 months. Maximum acceptable WTP was estimated using a Tobit model, recognizing that trip valuations may depend on current and planned visits to the Florida Keys.

A critical issue in the management and provision of coral reef access for snorkeling is to examine how the estimated marginal valuations from the WTP model depend on the recreationist's current and prospective number of trips. Leeworthy and Bowker (1997) suggest that a major limitation of current nonmarket valuation studies is the inability to forecast beyond current baseline conditions. Conservative modeling assumptions are typically invoked that demand for trips to the Florida Keys will increase and that the nonmarket economic user values will also increase. The contingent valuation model presented here suggests caution in applying these assumptions. Avid recreationists who plan to increase visits to the Florida Keys do not reveal higher WTP levels compared with visitors who have no plans for increased visits. Expenditure patterns may adjust as additional trips are planned, indicating the limitations of modeling approaches that predict trips and assume that current trip expenditures will be maintained without using information from an integrated valuation model.

Coastal coral reefs, especially in the Florida Keys, are declining at a disturbing rate, leading marine ecologists and reef scientists to emphasize the importance of establishing nonmarket values of coral reefs which can be used as inputs in assessing the overall cost effectiveness of coral reef management and remediation programs. The purpose of this paper is to use travel cost and contingent valuation models based on trips to the Florida Keys focusing on WTP to preserve the current water quality and health of the coral reefs. The stated and revealed preference models allow the marginal valuation of recreationists to adjust depending on current and planned trip commitments in valuing nonmarginal policy changes in

recreational opportunities. The integrated model incorporates key factors for establishing baseline amenity values for tourist dive sites, including perceptions of reef quality and dive conditions, the role of substitute sites, and the quality and availability of tourist facilities and recreation opportunities. The travel cost and WTP model differ in identifying critical variables and provide insight into the adjustment of trip decisions across alternative destination sites and the valuation of trips. In contrast to the travel cost model, a measure of the availability of substitute sites and total recreation activities do not have a significant impact on WTP valuations reported by snorkelers. Snorkelers engage in a relatively focused set of activities, suggesting that these recreationists may not shift expenditures to other sites or other recreation activities in the Florida Keys when confronted with increased access costs for the snorkeling experience.

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