A Travel Cost Approach to Valuation of Wetlands in Southern California and How Site Characteristics affect their Demand

By:

Douglas Dare
Christine Rorwick
Paul Ahrns
Kendra Luttio

In Consultation with:

Dr. Darwin Hall

Environmental Science and Policy 400

Economics Team

Spring 2009

Contents

Abstract

Ascertaining the value of wetlands habitat can be problematic and generally takes one of two approaches: the contingent valuation method or the travel cost method. This study measures the travel cost of visitors to determine the demand function associated with four wetlands sites. A linear regression of the data shows the functional relationship between price (travel cost) and quantity (number of trips taken in a year). Though wetlands are generally not valued in terms of their recreational benefit, the results from our analysis show that the number of trips taken to a site increases as distance and travel cost decreases. The results of the statistical analysis indicate that we cannot reject as implausible that travel cost does not affect number of trips taken ($\alpha = 0.05$, $p = 0.025$). The average consumer surplus was found to be $69.65 for each individual per visit. Based on this relationship, the yearly consumer surplus associated with recreational activities at a typical wetlands site is $3,608,246. Furthermore, the predicted value of a restored Los Cerritos Wetlands is $1,846,510.

Introduction

The economic value of a non-market good, like enhanced or preserved environmental quality, is not easily obtained through traditional methods of valuation such as land appraisals. Instead, contingent valuation and travel cost surveys make it possible to determine what people are willing to pay (WTP) for access to a preserved or restored wetlands habitat. The travel-cost method was first hypothesized by Harold Hotelling in the 1940's as a way to determine admission fees for national parks (Hotelling, 1949). This analysis utilizes a travel cost approach to measure the use values by recreationists of four local preserved or restored wetland areas. The sites in this analysis were chosen to reflect differences between site characteristics such as size, number of habitat types, length of trails, proximity, and whether the sites are restored or preserved. Together they represent the demand for the "typical" Southern California wetlands site. From a regression analysis of data to estimate the demand curve, it is possible to ascertain the value of use benefits associated with restoring an additional site and adding it to an existing resource system.

Public enterprises such as a preserved or restored wetlands habitat are intrinsically different from those that are competitive (U.S. Army Corps of Engineers, 1999). First, the size of a viable wetlands habitat is large relative to the market it serves. Secondly, public agencies do not work like competitive firms which determine the profit-maximizing price for entry. The absence of a market equilibrium price associated with a consumer's marginal benefit requires that a "surrogate price" be defined from the consumer's opportunity cost of time and travel. However, if outdoor recreation were supplied by competitive firms, market equilibrium would occur at the intersection of the demand and supply curves for wetlands.

Figure 1 shows a market for wetlands recreation. The demand for recreational activities is negatively sloped, assuming an inverse relationship between price and quantity demanded. The demand curve falls as a result of an increase in price due to, for examples, increases in fuel costs, increases in distance, and increases in length of time for travel. Additionally, Individuals will take fewer trips as price increases. The supply is upward sloping, reflecting the need for an individual to travel farther from home to obtain the same quality recreational opportunities as more individuals enter the market and congest their preferred site. The relationship between aggregate market demand and supply shows the economic relationships and how consumer behavior can be affected by changes in price.

Figure 1: Market Supply and Demand of Wetlands Recreation *(Adapted from U.S. ACE, 1999)*

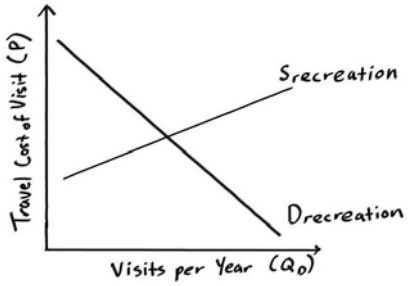
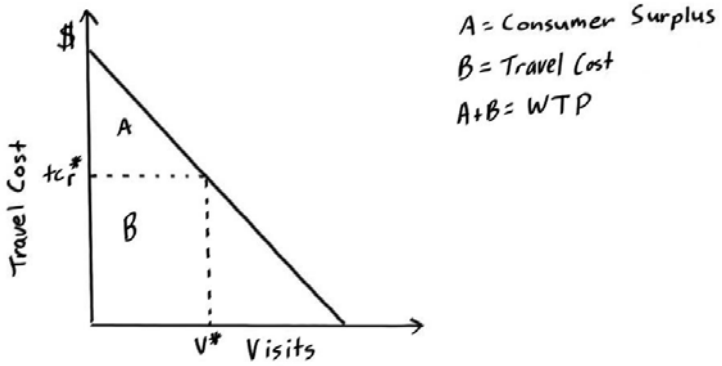


Figure 2 shows a travel demand curve for an individual consumer for the recreation at a wetlands site. Each individual's demand function reflects their personal satisfaction from recreating at the site, socioeconomic characteristics such as income and number of children, and a vector of the characteristics of that particular site. Again the demand is downward sloping, reflecting that an increase in price will result in fewer trips taken per season. The supply curve is horizontal because the distance from site to an individual's home is fixed. A shift in the supply curve may occur if fuel prices increase but it would still be horizontal because the number of trips does not affect the cost per trip. An increase in the environmental quality of a site would shift the demand curve to the right. The line at tc_r* shows the actual cost of travelling to the site in terms of time and trip cost. Additionally, the line at v* indicates the number of visits per year for the individual.

Figure 2: Individual Demand for Wetlands Recreation *(Adapted from Freeman, 2003, and USACE, 1999)*



The critical variable in the travel cost model is the cost of travel. Each individual has a different travel cost, and the variation between individuals generates the site demand data. A regression analysis of number of trips on the travel cost and socioeconomic characteristics of visitors, as well as characteristics of the sites visited determines the coefficients of the explanatory variables in the demand function. It is expected that the number of trips taken decreases as distance from site increases (that is, demand is downward sloping). Factors such as available leisure time and overall enjoyment for outdoor recreation also affect the number of visits per year[1]. Variation in travel cost for recreationists to their preferred site creates demand data. From this data a regression analysis may determine the statistical demand curve[2].

The summation of the upper triangle (consumer benefit) in Figure 2 for all of the individuals that recreate at a given site represents the total yearly value of that site. The travel

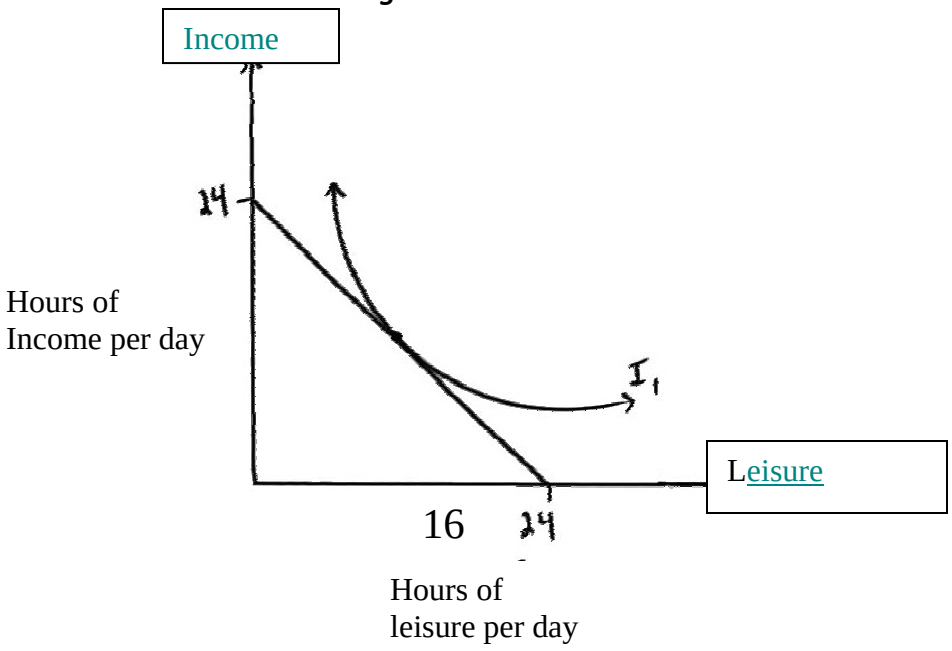
[1] Available leisure time and overall enjoyment for outdoor recreation were not measured in this analysis, but should be included in any future analysis as possible demand shifters.

[2] If the individual chooses the location of their home close to wetlands to minimize their cost of travel, then the travel cost is endogenous and not valid.

cost is equal to tc_r* multiplied by v*. The consumer's willingness to pay is the sum of their travel cost and their consumer benefit (areas A + B in Figure 2). The total yearly use value of the wetlands can then be measured by adding the willingness to pay for all of the individuals that recreate at that site. From the perspective of a policymaker, if this figure exceeds the yearly cost of restoring the wetlands, then the benefits outweigh the costs of such a project. It must be made clear that a travel cost study only captures the use value, but not existence values; it cannot calculate the value of intrinsic or environmental benefits such as the preservation of an endangered species or the value of the filtering services that wetlands provide.

The traditionally accepted theory of the tradeoff between income and leisure and the theory of allocation of time (Becker, 1965) is essential to the travel cost analysis. Figure 3 depicts a budget constraint of time in which an individual has to choose a combination of two goods, income and leisure. The opportunity cost of leisure is generally defined as income foregone. The opportunity cost of visiting a site is the individual's wage rate multiplied by the time they spend at the site and their round-trip travel time. The individual's utility depends on the total time spent at the site, the quality of the site, and the number of trips taken. The slope of the indifference curve is dependent upon the preferences of the individual; an individual who prefers leisure over income will have a different marginal rate of substitution than an individual who prefers income over leisure. The quantities on the constraint reflect the number of hours possible to be allocated between labor or leisure, and the wage rate. One issue that will be discussed later arises from the fact that only a relatively small subset of the population may exchange leisure for labor at the margin, since many professions are on a fixed, 40-hour work schedule and others like retirees and students often do not earn wages. In that case, the constraint is given by a point above the abscissa at 16. It should be noted that there is no consensus as how to value opportunity cost – some argue for as low as one third of the wage rate and others argue that the full wage rate is the relevant cost (Freeman, 2003).

Figure 3: Income vs. Leisure



Travel cost surveys make several assumptions, according to Freeman. Some assumptions applicable to this study and other travel cost studies in general are:

- First, that the wage rate is the relevant opportunity cost of time. For example, if someone worked enough only to pay their bills out of necessity, their value of time may be different than is implied by *this assumption*. Even for those who do value their leisure time equal to their wage rate, the trade-off may not be possible if they are working a fixed forty-hour work week salaried job. Marginal substitution for labor at the margin is not possible for many students, retirees, part-time workers, and full-time workers on a fixed schedule.

- Second, it is assumed that in all visits, recreating at the site is the sole purpose of the trip. Though only 1.21% of visitors indicated that their trip was for multiple purposes, this assumption inflates the total yearly value slightly as at least part of the trip cost is jointly shared between different purposes that are difficult to allocate. For the purpose of this analysis, all trips to wetlands are perceived as being for the sole purpose of recreating at the wetlands.

- Third, it is assumed that there are no substitute recreation sites available to these individuals. While some of the more sophisticated travel cost studies account for the substitute sites, for the purpose of this analysis, we assume that they are choosing a site specifically based upon its unique characteristics. These characteristics are measured as a proxy of site characteristics defined later in the Methods section.

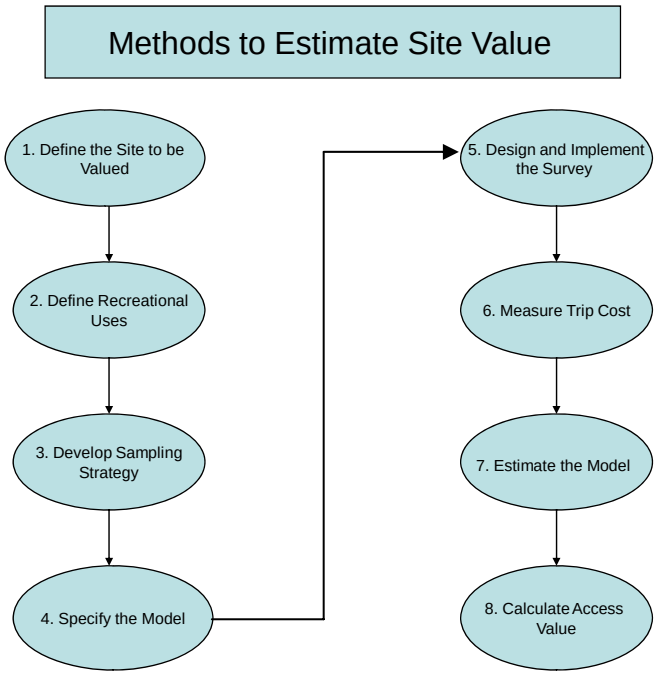
- Fourth, for the purposes of this analysis, it was assumed that all respondents drove. The price of travel cost was determined by multiplying the government mileage rate (U.S. DOT, 2009)[3] by the distance driven.

Though travel cost analysis is limited by these assumptions and does not measure all the benefits derived from the preservation or restoration of wetlands, its chief strength is that it is a "revealed preference" technique to measure utility based upon actual behavior that closely mimics other conventional economic valuations based on market prices. A contingent valuation does more completely measure all the benefits but, on the other hand, is a "stated preference" approach in which respondents address how much they would be willing to pay for specific environmental services. The contingent valuation is generally regarded to be more complicated and expensive to apply (Champ et al., 2003) and subject to its own limitations and issues.

[3] Currently $1.23/mile.

Methods

Figure 4: Methods to Estimate Site Value *(Adapted from Champ et. al., 2003)*

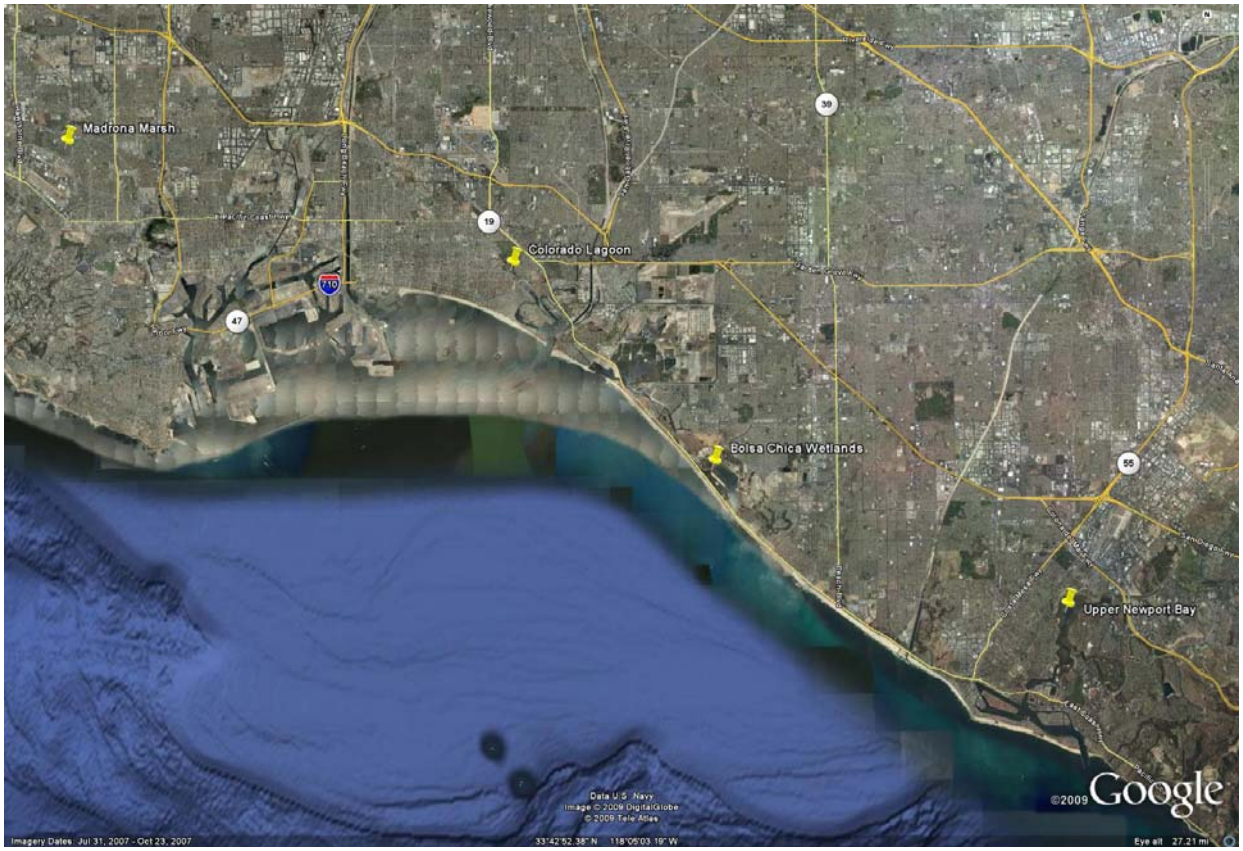


1. *Define the Sites to be Valued*

The sites valued in this study were Madrona Marsh in Torrance, Bolsa Chica Wetlands near Huntington Beach, Upper Newport Bay near Newport Beach, and the Colorado Lagoon in Long Beach (Figure 5). The sites in this analysis were chosen to reflect the differences between site characteristics including size, number of habitat types, length of trails, number of endangered & threatened species, proximity to the Los Cerritos Wetlands, and whether the sites are restored or preserved. Additionally, the Colorado Lagoon in particular was chosen to represent a baseline value to which the planned restoration can be compared at a future date.

Sites instead of the Los Cerritos Wetlands were chosen due to the fact that the demand for recreation at the Los Cerritos Wetlands is categorically low. Individuals will not trade wages for recreational time at a degraded and potentially contaminated site. Additionally, the Los Cerritos Wetlands is predominately in private ownership and cannot be easily accessed for recreational activities. By valuing sites other than the Los Cerritos Wetlands, this analysis attempts to capture the possible stream of recreational benefits resulting from acquiring and restoring an additional natural resource.

Fig. 5*: *Sites Surveyed



2. Define the Recreational Uses and Season

Common to three of the sites (Madrona Marsh, Bolsa Chica, and Upper Newport Bay) are activities such as photography, wildlife observation, environmental education and interpretation, bird-watching, and walking. Upper Newport Bay also allows for kayaking, bicycling, horseback riding, and dog walking. Recreational uses at Colorado Lagoon were barbequing, picnicking, swimming, and fishing. Due to the time constraints of the course, data collection was limited to the months of April and May, though all of these recreational activities can be pursued year-round.

3. Develop Sampling Strategy

Sampling was conducted on-site at each of the locations. Recreationists were intercepted at each site and asked to complete an oral or written survey. On-site samples have the advantage of hitting the target population directly as every person surveyed has visited the site on at least one occasion. One issue stemming from an on-site strategy is that people who do not visit the site are missed (Champ et al. 2003). This implies a sample with no observations taking zero trips, which in turn may compromise the accuracy of the "choke point" for the

demand function. On-site sampling also has a tendency to over sample frequent users of the sites as users that visit the site five times in a year will be five times as likely to be sampled. Another issue altogether is that random on-site sampling can be difficult in a spatial sense as some of the sites do not have a clear entry and exit point. Additionally, interviewing respondents who were running or bicycling was impossible and common courtesy made it difficult to approach a respondent engaged in various activities such as talking on their cell phone, listening to music, or taking pictures.

4. Specify the Model

Every travel cost model must include an individual's travel cost to the site (tc_r). Most models also include a set of demographic variables that are believed to influence the number of trips taken in a season. The demographic variables measured in this analysis include gender, number of dependents, whether the respondent was a member of an environmental organization (and if so, how many); interviews were limited to respondents over the age of 18. The travel cost model used in this analysis assumes that site visits are priced by their opportunity cost of time (travel and on-site) and out-of-pocket vehicle expenses.

Our model calculated the number of trips taken per year as being dependent upon the travel cost, their wage rate, demographics, and characteristics of the site they choose to visit. Data was pooled to generate a single demand function. Wage rate was determined by asking the respondent their yearly pre-tax household income and dividing that by the number of wage earners in the household and then dividing this by 2,000 hours of work per year. This assumes that everyone works full time and though this is not true, it is still debated in literature how to value time for retirees, students, homemakers, and the unemployed (Champ et. al., 2003). Demographic variables measured include gender, number of dependents, and how many, if any, environmental organizations they belonged to. Characteristics of sites included how many full time employees worked at the site, acreage, number of habitat types, number of restrooms, number of informational signs, number of endangered and threatened species that lived there, and miles of trails.

The equations used to calculate travel cost are:

$$v = f(tc_r, H, S, I)$$

Where v is the number of visits during a season
tc_r is the travel cost of a visit to the site
H is an explanatory variable of site characteristics for number of habitat types
S is an explanatory variable of site characteristics for number of endangered and threatened species multiplied by the number of environmental group memberships of each individual
I is an explanatory variable of demographics for income (in thousands of dollars)

$$tc_r = (w * [T_1 + T_2]) + (M * \$1.23/mile)$$

Where *w* is their wage rate
T_1 is time spent driving (round-trip)
T_2 is time spent on site
M is miles driven (round-trip)

(Adapted from Freeman, 2003).

5. *Decide on the Treatment of Multiple Purpose Trips*

Parsons and Wilson indicate that there is no logical way to identify the marginal cost of the recreation portion of a multiple purpose trip unless restrictions are placed on the model (Champ et al., 2003). A considerable portion of the respondents (88.8%) indicated that visiting the site was the sole purpose of their trip. For the sake of simplicity, in the analysis all respondents were assumed to make trips for the sole purpose. A more complicated but more precise analysis would attempt to apportion travel costs between the other purposes of the trip. Another approach would be to drop multiple purpose trips from the analysis altogether. According to Champ et al., the most common approach is to assume all trips are single-purpose for day trips.

Three of the surveys received indicated that the respondent lived more than 500 miles away from the site location, although we should have confined our survey to visitors who lived within the distance of a day trip. Their travel distance was recalculated to the distance from Los Angeles International Airport to the site as it seems unlikely to the authors that for such a trip visiting the wetlands was a sole purpose. We felt that this was necessary to ensure that all trips were treated as single purpose day trips. It seemed unlikely that an individual would travel over 500 miles for a day trip.

6. *Design and Implement the Survey*

The report from the 2006 Economics Team indicated that one obstacle to their contingent valuation analysis of the Los Cerritos Wetlands was the length of time it took for respondents to complete the survey. The survey for this analysis was designed to keep response times down to approximately two minutes. Though overall completion rates were not tallied, the authors feel confident that a high percentage of individuals approached for surveys (>90%) were willing to complete them. The area of responsibility for each of the team members are as follows: Doug Dare, Upper Newport Bay; Christine Rorwick, Madrona Marsh; Paul Ahrns, Colorado Lagoon; and Kendra Luttio, Bolsa Chica.

7. *Measure Trip Cost*

Trip distance and trip time was measured using Google Maps[4] from the zip code of the respondent's residence to the site being surveyed. Though respondents were asked in the

[4] http://maps.google.com/

survey how long they spent travelling, variations within the same zip code were noticed, therefore for the analysis we relied on data provided by Google[5]. All respondents were assumed to have driven automobiles and their vehicle costs were calculated using the U.S. Department of Transportation Privately Owned Vehicle mileage rate. It was assumed that no individuals had to pay a toll to get to the sites. Another assumption made in this analysis was that their equipment costs were zero as any equipment they have for their particular choice of recreation could be used at any other substitute site. None of the sites had an access fee, otherwise they would have been added to the travel cost. It was also assumed that none of the visitors paid for parking. In retrospect, these assumptions would have been easy to include in the questionnaire as part of the travel cost questions.

Arguably the most difficult issue with the travel cost approach is the treatment of opportunity cost of time. This analysis assumes that the wage rate can be traded at the margin for leisure. Bockstael *et al.* (1987), found a money/time tradeoff of $60/hour for individuals with fixed work hours and only $17/hour with flexible work hours. Persons who can trade work hours for leisure hours at the margin represent only a small portion of the overall population of recreationists. Retirees, students, the unemployed, and many part time workers cannot exchange time for wages. A more complicated model could create separate leisure time constraints for each level of occupational status (i.e. professional, student, retired, part time). According to Champ et al., 2003, the recreation literature has more or less accepted one-third as the lower bound and the full wage as the upper bound as a fractional value of wage as the value of time.

8. Estimate the Model

The equation that was used to calculate travel cost is $v = f(tc_r, I, H, S)$, where v is the number of trips during a season, tc_r is the cost of a visit to the site, I is income, H is an explanatory variable of site characteristics for habitat types, and S is an explanatory variable of site characteristics for number of endangered and threatened species multiplied by the number of environmental group memberships for each respondent (Freeman, 2003). Since we collected observations from only four sites, site characteristics are highly collinear. The number of endangered and threatened species was multiplied by the number of environmental group memberships for each individual to counteract the multi-collinearity of the two site characteristic variables and create an interaction term: it is logical that visitors who are members of more environmental organizations will more frequently visit sites with a greater number of endangered and threatened species than someone who is not a member. One simplification of the multisite model is to treat all observations as belonging to a single travel cost demand equation by pooling data. This yields the demand for a "typical wetlands site".

[5] Many respondents didn't know the mileage or travel times or else would revert to a common answer such as "10 miles" or "20 miles". A future analysis might be able to overcome this obstacle by having respondents take the surveys home so respondents have an opportunity to ensure their distance and time reported is more precise.

Description of Sites Surveyed and Observations

Madrona Marsh, City of Torrance

Madrona Marsh is a seasonal wetland that is located in the City of Torrance. The marsh is roughly 45 acres in size and is maintained by the City of Torrance and local volunteers. The marsh is surrounded on all sides by residential and commercial properties. This is similar to the Los Cerritos Wetlands Complex, and that was the primary reason for incorporation in this study.

The marsh is home to an estimated 166 types of plant and animal species. Of these species, 101 of them are on watch lists or are considered a species of concern. There are also five migrating species that are listed as endangered (Drake). The marsh has four major habitats. They include upland, alkali margin, vernal pools, and seasonal marsh. Within these four main habitats are microhabitats. They include dune scrub, grassland, and riparian woodland (Drake).

Madrona is a popular wetland for local residents. In 2008, 25,587 people visited the marsh (Drake). This may be due in part to the large number of tours and recreational activities that are available to visitors. A large number of these people also participated in restoration efforts at Madrona.

While Madrona is relatively small in comparison to Los Cerritos, it is a clear example of what a restored wetland could look like. The marsh has a nature center as well as regularly scheduled activities for visitors. These are valuable resources for visitors, as they inform us about the importance of California Wetlands.

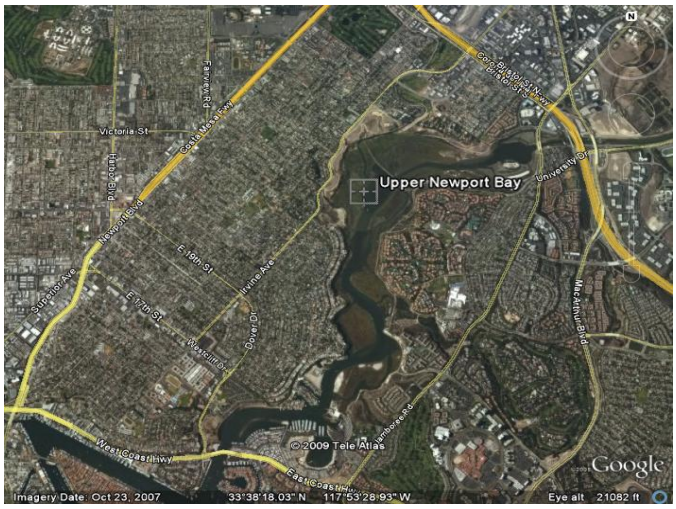
The surveys for Madrona Marsh were completed on Saturday, March 28 from 9:30 am until 2:30 pm. Surveys were initially conducted inside the nature center as this was where the majority of the activity was in the morning hours. A table was set up near the entrance to the nature preserve in the early afternoon because of concerns relating to the observation that many visitors do not utilize the nature center. Most of the surveys were conducted in the morning as there were fewer visitors in the afternoon hours.

The nature center was quite busy in the morning as many groups were gathering for guided tours provided by the wetlands staff, as well as restoration efforts. While conducting the

surveys, it was observed that a group of people from the Audubon Society were there for bird watching.

The biggest concern expressed by respondents related to the amount of time it would take to complete a survey. This did not become an issue because the majority of surveys took around one minute to complete.

Upper Newport Bay, City of Newport Beach



Upper Newport Bay is bounded between the 73 Freeway to the North, Pacific Coast Highway to the South, Irvine Avenue to the West, and Jamboree Road to the East. It drains runoff from approximately 154 miles of urban Orange County.

This wetland is 972 acres in size, and it is managed by three separate government agencies. The California Department of Fish and Game is responsible for 172 acres, the City of Newport Beach is responsible for 84 acres, and Orange County Department of Parks and Recreation are responsible for 40 acres. Upper Newport Bay has 7 miles of maintained trails and bike paths. These paths accommodate the estimated 122,427 visitors that come here each year (Stoffel, 2009). Generally 3-4 paid staff and 2-4 volunteers are on site every day to assist visitors and maintain the preserve.

Upper Newport Bay is home to hundreds of plant and animal species, of which ten of them are either endangered or threatened, such as the California Gnatcatcher, the Burrowing Owl, and Belding's Savannah Sparrow. There are six major

habitat types found at Upper Newport Bay: open water, mudflats, salt marsh, freshwater marsh/pond, riparian, and upland.

While the Upper Newport Bay is considerably larger than the Los Cerritos Wetlands, it is a good example of what a restored wetland may look like and how different government agencies with different mandates and agendas can come together to restore and preserve a habitat for the enjoyment and benefit of the public. Staff at Upper Newport Bay had 383 tours last year designed to educate the general public (Stoffel, 2009).

Observations at the site took place on the morning of April 19, 2009, from approximately 6:30 AM until 1:00 PM. Before 10:00 AM, it appeared that most of the recreationists were at the site for the purpose of physical exercise; most individuals were walking briskly, running, riding bicycles, or walking dogs. Once the Interpretive Center opened up at 10:00 AM, it appeared that families and individuals interested in the wetlands were more numerous. Both groups were sampled equally by the researcher conducting survey. Respondents were generally receptive about completing the survey but concerned about how long it would take. In the future, a survey should coordinate with volunteers and staff to set up surveying at a specific site such as near the trail head or the Interpretive Center to capture more of the values for recreationists specifically there for the wetlands.

Colorado Lagoon, City of Long Beach

Colorado Lagoon is a 29-acre wetland located in the City of Long Beach. It was once a part of the greater Los Cerritos Wetlands Complex that historically totaled 2,400 acres in size. Colorado Lagoon is managed by the city of Long Beach as a recreational park. Additionally, the Friends of the Colorado Lagoon, a local community organization, staff an educational center inside the park. The lagoon has 29,200 visitors a year. Most visitors to the lagoon come for barbeques and family activities. Additionally, the Friends of the Colorado Lagoon host walks, clean-ups, and educational activates associated with the current restoration effort.

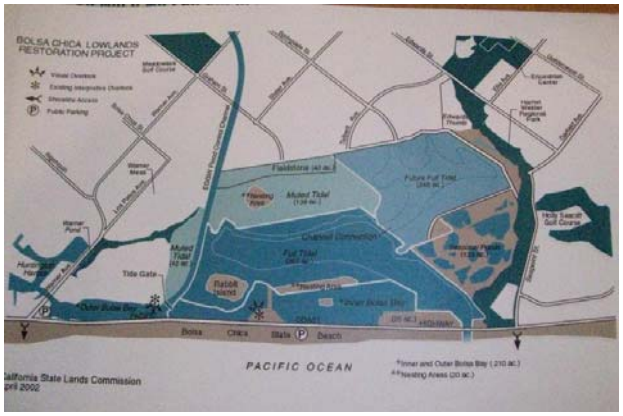
Colorado Lagoon has six major habitats. They include sub tidal, inter tidal, dune scrub, bluff, upland and urban recreational. These habitats are home to 3 endangered or threatened species, including the California Brown Pelican, the California Least Tern and California Sea Blite. The Colorado Lagoon was chosen as a wetland site for this survey because it is the closest

wetland geographically to the Los Cerritos Wetlands and is in the process of being restored. After the restoration at the Colorado Lagoon is complete, it will be possible to perform another travel cost survey to determine the change in visits and valuation of the site. Furthermore, the restoration of the Colorado Lagoon will provide indispensable habitat for local plants and animals. A restored Colorado Lagoon would also provide guidance in the restoration of the Los Cerritos Wetlands.

The Colorado Lagoon is a small wetlands site with predominately recreational park space. Because of this, the types of activities enjoyed at the Colorado Lagoon are dramatically different from those at the other wetlands sites surveyed. While some respondents at the site were fishing and bird watching, the typical respondent was engaged in family activites such as barbeques and picnics.

Observations at this site took place on Saturday , April 11th and Sunday, April 12th from 10:00 am to 2:00 pm. The surveys were collected by walking along the main trail through the park. Most visitors were willing to complete the survey when asked and told the survey would only take a few minutes. The main restrictions on willingness to complete the survey were limited knowledge of English and the presence of young children.

Bolsa Chica, City of Huntington Beach



Bolsa Chica is a 1200 acre undeveloped wetland in the City of Huntington Beach. One hundred eighteen acres of Bolsa Chica are upland habitat reserved for the breeding and nesting of birds. Restoration began at Bolsa Chica on October 6, 2004. The restoration included the removal of 61 oil wells and over 121,000 feet of pipe. The restoration has made Bolsa Chica an integral stop for migratory birds along the pacific flyway. In fact, more than 200 species of birds have been observed. The reserve is also home to a variety of plants, insects, reptiles, mammals, fish and raptors. Six of the species that reside at Bolsa Chica are endangered; one example is the Bald Eagle. Fourteen species that live here are listed on the California or Federal list of species of concern. Examples of these include the White Tailed Kite and Burrowing Owl. The Southern Tar Plant and Coast Wooly Head are two rare plants that can be found at Bolsa Chica. Bolsa Chica has a total of six habitat types. They include sub tidal, mud flats, low marsh, mid marsh, high marsh, sand dunes and freshwater. There are currently 5 miles of maintained trails for visitors to explore the wetlands.

Bolsa Chica Lowlands Restoration Project Taken Aug-26-2006

This site was visited on Sunday, April 5th and Wednesday, April 13th. On Sunday April 5th, the surveys were given from 11:00 AM until 12:30 PM near the vicinity of the walking bridge. It was observed that the parking lot was overflowing with cars and people were double parking to get to the location. There were many bird watchers and photographers enjoying the abundant wildlife that was in the area. Respondents of the survey were very receptive; every respondent that was asked completed a survey. Some asked the length and were pleased to discover that it would take a short time. There were many families that set out to walk the five miles of trails. A stop at the visitor center was made on Wednesday, April 13th. It is a small structure with a parking lot and various educational signs. The visitor center is small and located away from the main entrance to the wetlands. This is a problem because it is located off the main road and many people do not know that it exists. The walking bridge from the main entrance is the main site where the majority of the 30,000 annual visitors go to enjoy the Bolsa Chica Wetlands.

Results

The linear regression of the data collected at the four sites shows the functional relationship between travel cost and number of visits. There are three components of the regression:

1. Linear equation of best fit (y = ax+b)
2. Nature of response (increase/decrease)
3. Whether there is a statistically significant relationship between the explanatory variables and number of visits

The linear equation of best fit based upon our regression is

$$V = -60.414 + -.191tc_r + .486I + 13.872H + 3.944S$$

Where

V is the number of visits to the site per year
tc_r is the travel cost to the site
I is the individuals' income in thousands of dollars
H is the number of habitat types at the surveyed site
S is the number of endangered and threatened species multiplied by the number of environmental group memberships of each individual

The coefficients of these variables indicate how a change in each variable will affect the estimated number of visits to a given wetlands site. The coefficient of opportunity cost is -.191; this value means that for every dollar increase in cost to visit a wetlands site, there will be a .191 decrease in visits per year. More clearly, for an approximate increase in cost of $5 will result in one fewer trip to the site. The income coefficient is .486. This value tells us that for every $1000 increase in income, there will be an increase in site visits of .486 or 1 additional trip for every additional $2000 earned. Additionally, the coefficient 13.872 for the number of habitats shows that sites with more habitats will have patrons that visit more frequently. This would lead policy experts to prefer a wetlands restoration plan with the highest number of habitat types. Finally, the coefficient of the number of endangered and threatened species multiplied by the number of environmental group memberships was found to be 3.944. This shows that increases in the number of rare species will increase visitation to a wetlands site, at least among those who are members of an environmental organization. This result has policy implications as well, because a restored wetlands site would be better equipped to host rare plant and animal species. Therefore, when restoring the Los Cerritos Wetlands, two of the guiding principles should be diversity in both habitat types and rare species.

All of the variables used in the analysis were found to be significant. Income, opportunity cost, and environmental memberships multiplied by rare species were statistically

significantly different from zero at the .05 level. The number of habitats was not significant at .05 but was at .10. Therefore, all variables in the analysis were significant to at least the .10 significance level.

The wetlands listed in decreasing order of sample share for the travel cost estimation are: Madrona, 30.49%, Bolsa Chica 24.39%, Upper Newport Bay 24.39%, and Colorado Lagoon 20.73%. The average visit length to each site is: Madrona 1.67 hours, Bolsa Chica 1.09 hours, Upper Newport Bay 1.53 hours, and Colorado Lagoon 3.07 hours.

Madrona Marsh averaged 4.68 visits per year at a length of 1.67 hours with an average trip cost of $65. Upper Newport Bay averaged 53.4 visits per year, 1.53 hours, with an average trip cost of $86. Bolsa Chica averaged 15.6 trips per year at 1.09 hours each with an average trip cost of $125. Colorado Lagoon averaged 40.5 visits per year at 3.07 hours each and a cost of $167 per visit. The average number of visits throughout the entire sample is 26.6 visits per year for 1.78 hours with a travel cost of $106 per trip.

Figure 6:

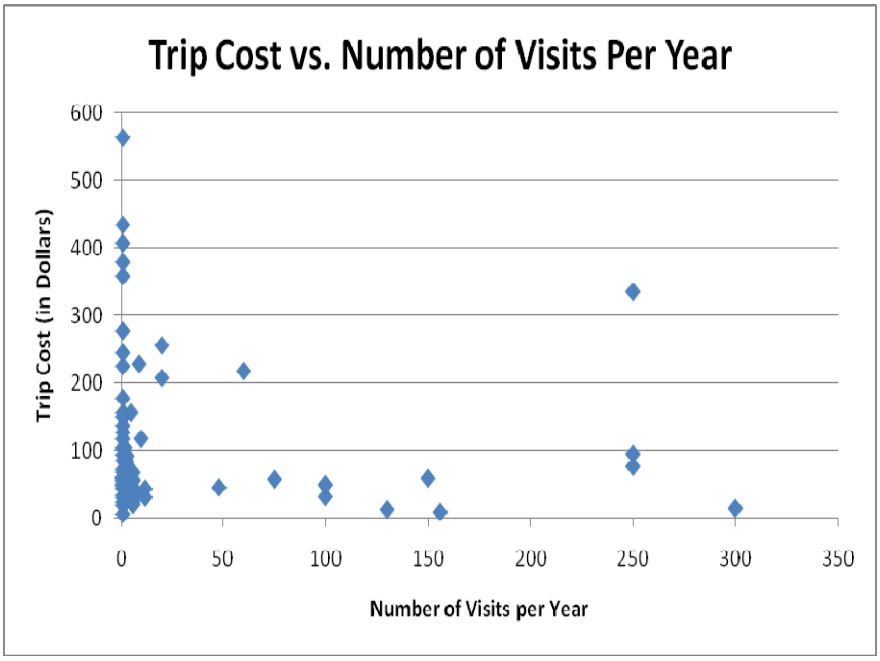


Figure 6 shows the variation in travel cost used to generate demand data for the sites. The statistical demand function is fitted to the data in Figure 6 using regression analyis. Non-monetary factors affect the demand function as well. The function of the survey is to account for all of these factors and incorporate them to explain the willingness to pay for outdoor recreation.

Figures 8, 9, 10, and 11 show some characteristics of the respondents at each site. Respondents at Colorado Lagoon deviate significantly from the other three sites surveyed significantly in terms of average visit length, average visit cost, and percent of visitors that belong to an environmental organization. All four groups widely varied in terms of the average number of visits per individual annually. Upper Newport Bay and Colorado Lagoon averaged 53.4 and 40.5 visits per year respectfully. The average visit length at Colorado Lagoon is approximately two to three times that of the other sites. Probably the single biggest factor contributing this difference between the sites relates to the types of activities that take place at the Colorado Lagoon such as barbeques and picnics.

Figure 8:

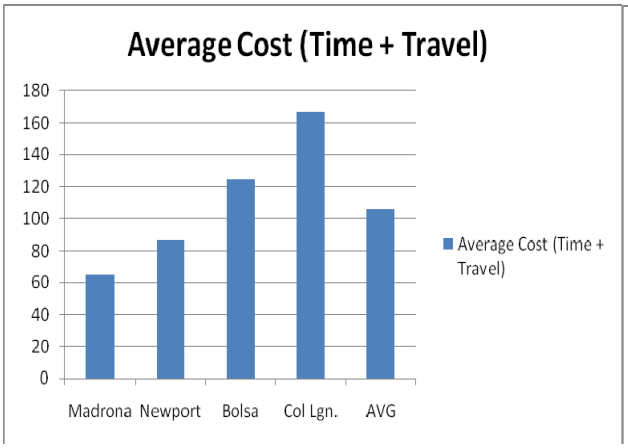


Figure 9:

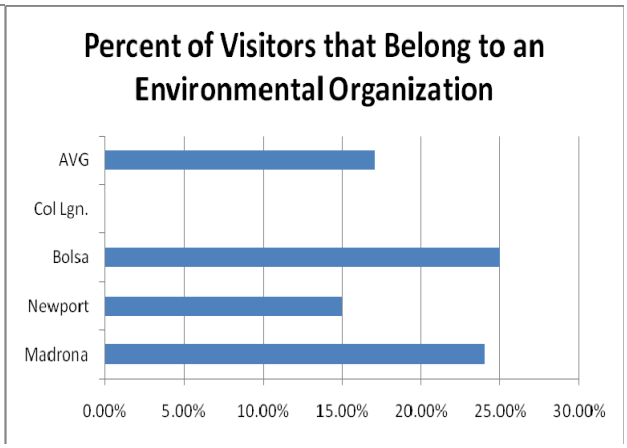


Figure 10:

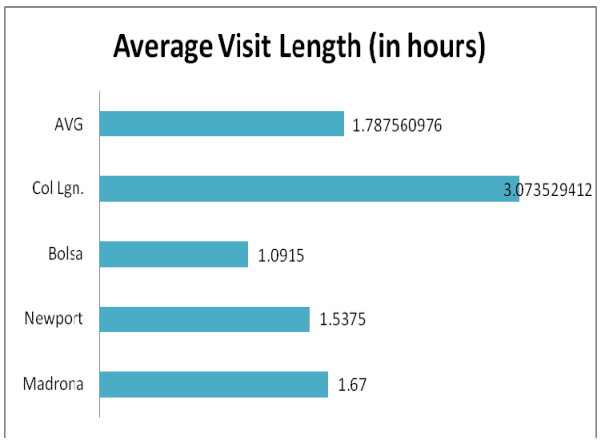
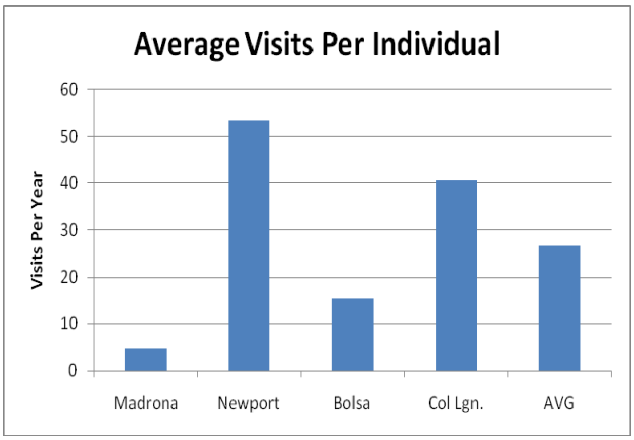


Figure 11:



Figures 12, 13, and 14 depict the distribution of trips between all of the sites by time, distance driven, and travel cost. These histograms indicate that between all sites the number of trips decreases as distance or travel cost increase, *et ceteris paribus*. Conversely, more trips are taken the closer an individual lives to a site.

Figure 12:

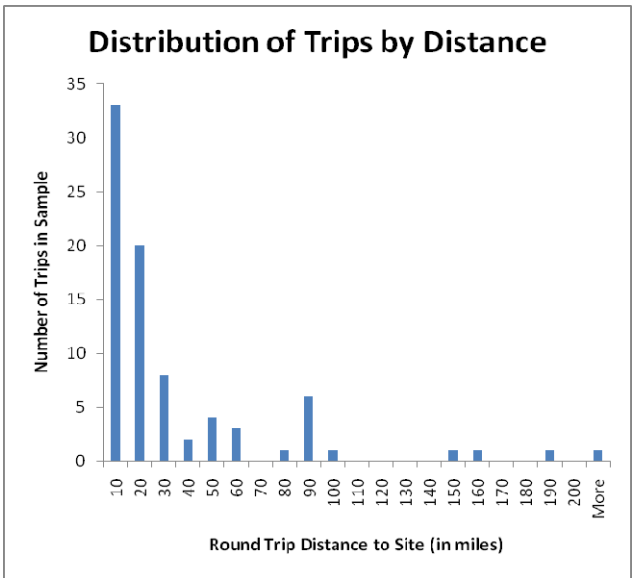


Figure 13:

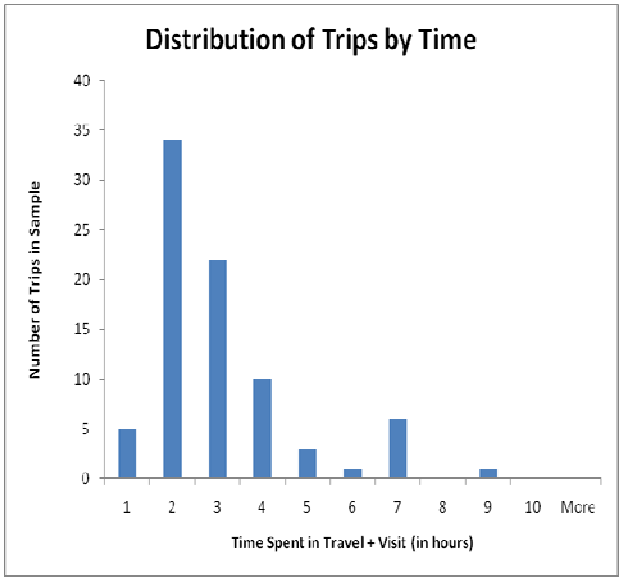
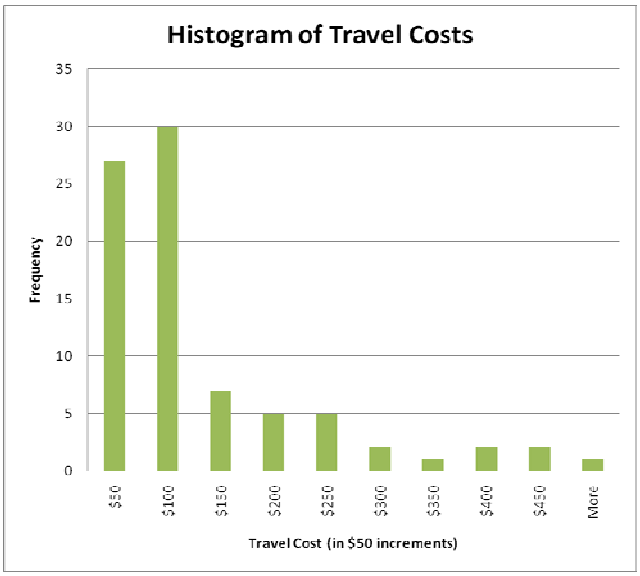


Figure 14:



SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.451630508
R Square	0.203970116
Adjusted R Square	0.162617914
Standard Error	58.07969974
Observations	82

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	66554.37671	16638.59418	4.932509204	0.001357888
Residual	77	259740.3672	3373.251522		
Total	81	326294.7439			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-60.41363177	38.93482773	-1.551660436	0.12484421	-137.9427774	17.11551383
Opportunity Cost + Vehicle Cost	-0.191280394	0.076451736	-2.501975804	0.014471214	-0.343515248	-0.039045541
income (in thousands)	0.486078655	0.176049704	2.761030805	0.007199776	0.135518914	0.836638396
Number of Habitat Types	13.87225673	7.435065716	1.865788046	0.065879546	-0.932850316	28.67736378
Env Orgs * species	3.944027363	1.384314884	2.849082539	0.00562162	1.187504311	6.700550416

Site Name	Overall Percent of Sample	Avg Visit Length (Hours)	Avg Visits per Year	Percent of Respondents Who Make Additional Stops	Percent Male	Avg Travel Time (Hours)	Percent of Respondents Belong to Env. Orgs	Percent With Dependents	Average Trip Distance	Average Wage Rate ($/hr)	Average Cost (Time + Travel)	Annual Visitors	Avg. Cost * Annual Visitors (Total Yearly Value)
Madrona Marsh	0.3049	1.67	4.68	0.04	0.48	0.41	0.24	0.44	10.46	26	65	25587	1664969.8
Upper Newport Bay	0.2439	1.5375	53.4	0.25	0.4	0.35	0.15	0.5	10.51	38	86	122427	10553042.1
Bolsa Chica	0.2439	1.0915	15.6	0.25	0.5	1.06	0.25	0.45	48.16	26	125	30000	3749877
Colorado Lagoon	0.2073	3.0735	40.5	0.06	0.5882	1.17	0	0.71	58.89	25	167	29200	4874764.8
AVG	N/A	1.7876	26.6	0.15	0.4878	0.71	0.17	0.51	29.71	29	106	207214	5489093.91

Relevance to Policy

The travel cost model is commonly applied in cost-benefit analyses and in natural resource damage assessments where recreational values associated with the environment play a role (Champ et al., 2003). Often the basis for a given policy decision or justification for a project will have a foundation upon some form of cost-benefit analysis. Agencies such as the Army Corps of Engineers and the Office of Management and Budget use cost-benefit analyses when making rules and regulations. As stated previously, the summation of the upper triangle (consumer benefit, area A) in Figure 2 for all of the individuals that recreate at a given site represents the total yearly use value of that site. If the total yearly use value of a proposed wetlands restoration project is greater than its yearly cost, then it would be justifiable using a cost-benefit analysis. Total yearly use values (consumer surplus) for each site are as follows:

- Madrona Marsh: 25,587 visitors * $46.87/visit = $1,199,160
- Upper Newport Bay: 122,427 visitors * $132.62/visit = $16,236,684
- Colorado Lagoon: 29,200 visitors * $4.08/visit = $119,186
- Bolsa Chica: 30,000 visitors * $90.90/visit = $2,727,006
- "Typical" Site: 51,803 visitors * $69.65/visit = $3,608,247
- Predicted Los Cerritos 27,794 visitors * $66.44/visits = $1,846,510

The value for a "typical" site was determined by using averages across all four sites in the sample. The total consumer surplus for a predicted Los Cerritos wetlands site was found to be $1,846,510. This value was determined using the data from Bolsa Chica and Madrona Marsh because of their perceived similarity to a restored Los Cerritos Wetlands. The figures derived in this study indicate the recreational value associated with wetlands restoration and preservation. It is important to consider that travel cost analyses do not measure the existence value or the value of services provided by the wetlands such as their filtering ability or providing habitat for endangered species. As such, they represent a partial, conservative figure of the true value of wetland habitats. Measurement of non-use values are best approached using a contingent valuation technique.

While this project focused primarily on economics, it should be noted that the information gathered may be relevant to professions such as resource specialists, wetlands biologists, ecologists, and environmental planners. The statistical analysis determined that number of habitat types affected the demand in a positive manner and is indicative of the environmental quality of a site. As indicated in the Results section, a goal of policy in terms of restoration plan design would be to incorporate as many habitat types to promote biodiversity to increase the demand for a possible wetlands restoration.

Enhancing the environmental quality would shift the demand curve to the right (Freeman, 2003). One possible use of this study would be to use it as a baseline from which to measure the change in WTP as a result of the planned restoration of the Colorado Lagoon. Future ES&P 400 economics teams may find it worthwhile to measure if and how demand for that site changes as a result of its restoration.

Conclusion

The area under the demand curve is the measure of the value of flow of services based on the assumption that the demand curve is known with certainty (Freeman, 2003). One of the deficiencies with this regression analysis is the relatively high standard error (58.08) that may undermine the validity of our determination of value. While the travel cost method is useful in determining recreational value, attention should be placed on the survey design as well as on the sampling strategy and determination of sites. If possible, data should also be collected at different times and days of the week to obtain a truly representative sampling. A more thorough survey design would account for additional demographic variables and environmental quality/site characteristics that may modify an individual's demand curve. Other analyses may find it necessary to limit the number of trips an individual takes in a given year, as one of the sites had six visitors who recreated at the site more than 100 times a year[6] which were considerably higher than those reported at other sites.

The statistical demand curve needs to incorporate all of the factors that affect each individual's willingness to pay. Future travel cost analyses should seek to incorporate more socioeconomic factors into the survey design such as the occupations of respondents (whether working full time, part time, retired, unemployed, or a student), level of education, and overall experience in activity. A more complicated model would account for the role of substitute recreational sites towards values. Future analyses may focus more heavily upon site quality as one of their explanatory variables. Quality can be measured as a proxy of scientific data such as dissolved oxygen concentration, pH of a water body, or can be derived from questions asked of recreationists (Freeman, 2003).

The brevity of the survey we designed is a double edged sword: we were able to obtain high response rates compared to the 2006 Economics Team contingent valuation survey at relative ease but at the expense of the variables we could consider in the regression analysis. A more detailed survey design may find it necessary to offer some kind of incentive such as a raffle to respondents in exchange for their time. The Economics Team initially set out to obtain 80 surveys (20 per researcher) and was able to meet that objective without a problem. Future researchers may want to put a greater amount of time planning the execution of the surveying and defining the sites and what types of recreational activities they would like to sample.

[6] One particularly devoted individual at Upper Newport Bay said she recreated at the site every single day.

Wetlands Valuation Survey

Good Afternoon, this survey is being conducted by students in the Environmental Science & Policy Department at California State University, Long Beach. Please understand all responses will be anonymous and will be used purely for analysis.

Trip Information:

1. Are you over the age of 18? _____
2. How many times a year do you visit this site?

   _____
3. When you visit this site, what is your average length of stay?

   _____
4. What is the average travel time from your home?_____
5. What zip code do you live in? _____
6. Do you ever visit other wetlands in the area? If yes, please list them and the number of times you visited them in the past year?_____

   _____
7. Was visiting this site the sole purpose of your trip? If no, please list the other reasons for making your trip today._____

   _____
8. Did you or do you plan to shop or eat at any local restaurants today? which? _____

Background Information:

9. Sex:_____
10. Number of dependents:_____
11. Do you belong to any environmental organizations? If yes, how many do you belong to? _____
12. Yearly total household income before taxes (Select from the values at the right of this page):_____
13. Number of wage earners in your household:_____

Less than
A. $5000
B. $10,000
C. $15,000
D. $20,000
E. $25,000
F. $30,000
G. $35,000
H. $40,000
I. $50,000
J. $60,000
K. $70,000
L. $80,000
M. $90,000
N. $100,000
O. $125,000
P. $150,000
Q. $175,000
R. $200,000
S. $250,000
T. $300,000
U. $400,000
V. $500,000
Greater than
W. $500,000

References

Bateman, I. J., et al. (2002). Economic valuation with stated preference techniques. A manual. Cheltenham, United Kingdom, Northampton, MA: Edward Elgar.

Becker, G. S. (1965). A theory of the allocation of time. *The Economic Journal*, 75(299):493-517

Champ, P. A., Boyle, K. J. and Brown, T. C. (2003). A primer on nonmarket valuation. Dordrecht, The Netherlands: Kluwer Academic Publishers.

City of Torrance, (2004). Madrona Marsh Nature Center. Retrieved February 27, 2009 from http://www.ci.torrance.ca.us/Parks/6618.htm

City of Torrance, (2004). Madrona Marsh Preserve, City of Torrance. Retrieved February 27, 2009 from http://www.torrnet.com/Parks/6642.htm

Drake, T. <tdrake@torrnet.com>. Manager/Naturalist, Madrona Marsh Preserve. Personal email, (April 10, 2009).

Feather, P. and Shaw, W. D. (1999). Estimating the cost of Leisure Time for Recreation Demand Models. *Journal of Environmental Economics and Management* 38(1): 49-65.

Freeman III, M. A. (2003). The measurement of environmental and resource values. Theory and methods. Washington, DC: Resources for the future.

Friends of Madrona Marsh. The Madrona Marsh Preserve. Retrieved February 27, 2009 from http://www.friendsofmadronamarsh.com/

Hotelling, H. (1949), Letter, In: An Economic Study of the Monetary Evaluation of Recreation in the National Parks, Washington, DC: National Park Service.

Mapquest. [Map of the City of Torrance, California]. Retrieved April 10, 2009 from http://www.mapquest.com

San Francisco Estuary Institute. Southern California Wetland Tracker. Retrieved February 17, 2009 from http://www.wetlandtracker.org/

Sohngen, B. (1998). The value of day trips to lake Erie beaches. Retrieved March 15, 2009 from http://aede.osu.edu/people/sohngen.1/beach/daytrip.pdf

Stoffel, Susan. Resource Specialist, Orange County Department of Parks and Recreation. Personal email, dated 04/20/2009.

United States General Services Administration. "Privately Owned Vehicle (POV) Mileage Reimbursement Rates." Retrieved April 28, 2009 from http://www.gsa.gov/Portal/gsa/

United States Army Corps of Engineers. June 1999. "Outdoor Recreation Use and Value on Lower Snake River Reservoirs." Retrieved April 27, 2009 from http://www.nww.usace.army.mil/lsr/reports/outdoor_rec/outdoor.htm