The Value of a Wave

An Analysis of the Mavericks Region
Half Moon Bay, California

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"Mavericks is a great place to witness how awesome nature is
– and how powerful man can be to preserve such a place."
- *Anonymous survey participant*

1. Introduction

Surfing is one the most popular ocean sports worldwide. Surfing originated in Polynesia and, in particular, in Hawaii roughly 1,000 years ago (Finney and Houston 1966, 23). Surfing was "the sport of Hawaii's kings" and was called "Hee Nalu" or "wave sliding." In 1907, an Irish-Hawaiian by the name of George Freeth introduced the sport to southern California. In 1912, Duke Kahanamoku stopped in California on his way to the Olympic competition for swimming (Finney and Houston 1966, 90-91). Kahanamoku, who is known as the grandfather of modern surfing, further popularized the sport within the southern coastline. The advent of the wet suit allowed surfing to both flourish in northern California and in the wintertime, when waves are bigger. One of the most notorious big-wave surfing spots is Mavericks, in Half Moon Bay. Big-wave surfers travel from all over the globe to ride Mavericks up to 50-foot faces.

This study was commissioned by the Save the Waves Coalition to determine the value of the Mavericks surf area to the local community and beyond. All data was collected by Save the Waves and provided to the University of Hawaii. Data was collected over a five-month period and 358 people were surveyed at the Mavericks surf area.

The survey data collected was used to build an Individual Travel Cost Model (ITCM) to estimate the annual welfare accrued by visitors to the Mavericks surf area. The average visitor is estimated to receive $56.7 in consumer surplus per trip to the Mavericks surf area. With an estimated 421,431 visitors annually,[1] the total annual net economic value to Mavericks visitors is estimated at $23.8 million. In addition, surfers are estimated to visit the area nearly five times more often than non-surfers and thus accrue more value from the area.

2. Background

There is a growing interest in understanding the value of surfing. A study on the Mundaka surf break in Mundaka, Spain estimates the economic impact of the wave to the local community through tourism revenue. The wave was of particular interest because it was a stop along the prestigious Billabong Pro surf contest prior to a 2004 river dredging project that negatively altered the dynamic of the wave (Murphy and Bernal, 2008). Similarly, a 2006 study on the Vans Triple Crown of Surfing contest on the North shore of the island of Oahu, Hawaii estimated the direct and indirect economic impacts of the 7,000 participants and spectators (Surfer Magazine, 2009).

[1] As no other data source is available, this is based on a very generalized estimation process using a headcount of beach visitors during survey days. Details on the population estimation are provided in section 4.

These prior studies focused on the *economic impacts* of the industry to local economies. Another aspect of economic value, however, comes from the welfare or benefit that surfing provides to surfers and observers. This perspective takes that of "consumer welfare" and thus focuses on economic *value* rather than economic *impact*.

2.1 Valuation Techniques

Economic valuation of environmental services and amenities is based on peoples' willingness to pay for such environmental goods and services. There are three basic components of value, where an individual's total willingness to pay is composed of willingness to pay for "use value," "option value," and "intrinsic value" (*Total Willingness to Pay = use value + option value + intrinsic value*). Use value is the direct benefit derived from consumption; option value is the benefit derived from having the choice to consume (i.e. the possibility of use in the future); and intrinsic value, also known as existence value, is the benefit from knowing a good exists (Tietenberg, 2007). Because markets are notoriously poor at properly valuing environmental amenities (due to issues of common property, public access, and a host of issues associated with externalities), the value of environmental goods and services must often be assessed using methods other than market observation.

Many valuation techniques are based on the tradeoffs or sacrifices that people make in their life choices; such as paying more for houses in areas that are perceived as of higher environmental quality, or accepting a reduction in income for living in such areas or traveling to visit these areas in lieu of other recreation activity.

Valuation techniques are either based on information revealed through consumer actions or inferred based on stated preferences. Revealed preference methods are based on peoples' past behavior. Revealed preference methods assess "use value," and, in some cases (hedonic pricing), "option value." Stated preference methods can assess all three values. Stated preference methods are accompanied, however, by the challenges of positing hypothetical scenarios that people may or may not perceive as realistic.

This report uses the Individual Travel Cost Method (ITCM) to assess the value (welfare) accrued to the users of the Mavericks surf area. TCM is the most frequently used revealed preference method (Rosenberger and Loomis, 2000) and is widely used to establish recreational values of environmental amenities. It has been "commonly used for decades to estimate a recreation demand curve empirically" (Loomis and Keske, 2009, 428). It is considered a relatively conservative measure as it is based on a *minimum* willingness to pay assessment. This method is based in the assumption that how much people pay in their travel to a location must be, at a minimum, representative of their willingness to pay for the environmental amenity. Due to statistical inefficiency and problems with using aggregate averages associated with the Zonal Travel Cost approach, we chose to collect detailed information on individuals visiting the Mavericks region over a five-month period. Data were collected from early February through late June. This timeframe included both the end of the surf season at Mavericks beach as well as the beginning of the popular summer tourist season, which brings visitors to the Mavericks region to enjoy

the natural amenities. Details on data collection and model construction are provided in the next section.

3. Data Collection and Construction

Although a combination of on-site and on-line data was collected, only the on-site data is used to inform the Individual TCM model and, ultimately, to estimate of the value of the Mavericks surf area. This decision was made because the on-line survey inherently suffers from selection bias, attracting those who are affiliated and/or familiar with Save the Waves Coalition rather than being more representative of the beach visitor population.

The on-site surveys were collected over nine survey days, ranging from February 7 through June 27, 2009. In this time, 359 surveys were conducted.[2] Survey questions ranged from modes of travel to reasons for visiting the Mavericks surf area to describing the primary reasons for the trip. These reasons included: to surf, to watch the surf, for the surfing community, to see the waves, and to visit family and friends. For the full survey instrument, see Appendix I.

In addition, zip codes and car types were collected in order to assess the distance and cost of travelling to visit the Mavericks surf area. If someone traveled through a mode other than a passenger vehicle, that information (e.g., cost of airline ticket) was also recorded. To assure that the entire value of the trip was not unduly attributed to the visit to Mavericks, participants were asked whether Mavericks was the primary purpose of their trip. If so, the entire cost of the trip was attributed within the "travel cost" estimate. Otherwise, only half the value of the trip was attributed as such.

For visitors using passenger vehicles, travel cost was calculated to be the two-way distance traveled divided by the fuel economy of the vehicle multiplied by the cost of gasoline. Passenger vehicles were divided into compact, sedan, and S.U.V. categories and the average fuel economy for each general type were taken from the Environmental Protection Agency (http://www.fueleconomy.gov/). The average price of gasoline in the Half Moon Bay area during the study period was $2.95 (http://www.eia.doe.gov/).

Demographic variables were also recorded, as factors such as age, income, and gender are expected to influence the number of annual trips to the Mavericks region. Summary statistics for our variables of interest are provided in Table 1.

[2] For comparison, Loomis and Keske (2009) collect data on hiking in Pikes Peak over five separate days. A total of 206 surveys were distributed there was a response rate of 55% (due to the mail-back aspect). They had 89 usable observations.

Table 1. Summary Statistics.

Variable	No. of Observations	Mean	Standard deviation
Annual trips	359	17.64	48.23
Travel cost	359	19.18	114.60
Age	224	44.57	16.39
Income	195	94,297.08	91,280.96
Gender (female=1)	359	0.24	0.43
See Waves	359	0.08	0.28
Watch Surfing	359	0.03	0.18
To surf	359	0.07	0.26
Surfing Community	359	0.01	0.07
Family and Friends	359	0.14	0.35

Because there were incomplete responses for the age and income categories, these observations were dropped from the dataset (leaving 195 usable observations). Due to the large standard deviation associated with the travel cost variable, and because most responses were people from the local area, we truncated the data by including only those visitors with an average travel cost of $100 or less. This decision was made to address those who flew to California, because it was difficult to determine what portion of the cost of their flight was attributable to their trip to Mavericks. This brought us to a final data set of 151 observations.

4. Methodology: An Individual Travel Cost Model

The Individual Travel Cost Model uses annual trips per person as the dependent variable, and uses travel cost and other relevant factors as explanatory variables. The simplest version would use travel cost alone to estimate how many trips the average visitor makes to the Mavericks area. Other factors that are likely to explain visitation rate are characteristics such as the visitor's interests in the area (surfing, friends and family, etc.), and demographics such as age, income, and gender.

Once the appropriate explanatory variables have been assembled, the regression equation gives us the demand function for annual trips for the "average" visitor to the Mavericks region, and the area below this demand curve provides an estimate of the average consumer surplus. We then multiply average consumer surplus by the total relevant population to produce an estimate of total consumer surplus for the Mavericks region.

A general equation describing annual trips to the Mavericks region is given by Equation (1).

$$AnnualTrips_i = \beta_0 + \beta_1(TC_i) + \beta_2(X_i) + \beta_3(reasons_i) \quad (1)$$

where $AnnualTrips_i$ is the number of trips made by visitor i in one year, TC_i is travel cost of visitor i, X_i is a vector of demographic variables describing individual i, and $reasons_i$ is a vector of reasons individual i visited the Mavericks surf region.

Functional forms often used to address count data (data in which the observations can take only non-negative integer values and where these integers arise from counting rather than ranking) are either Poisson or negative binomial models. These are commonly used functional forms associated with Travel Cost Models (Wang et al. 2009). We began our analysis with the Poisson model, but ran into issues with overdispersion— that is — greater variance than might be expected in this type of distribution, resulting in failures of standard goodness-of-fit tests.[3] The large value for chi-square in our goodness-of-fit test was another indicator that the Poisson distribution was not an adequate functional form. We followed the Poisson model with a negative binomial regression, as the negative binomial regression is often more appropriate in cases of overdispersion. The likelihood ratio test provided by Stata's negative binomial command is a test of the overdispersion parameter alpha.[4] When the overdispersion parameter is zero the negative binomial distrbution is equivalent to a Poisson distribution. In our case, alpha was significantly different from zero, reinforcing that the Poisson distribution was not appropriate. However, the negative binomial regression provided very poor Pseudo R^2s in most sensible specifications. Following Loomis et al. 2009, we then turned to Ordinary Least Squares (OLS) using a semi-log model.

The semi-log functional form mimics the functional form associated with count data models (Loomis et al. 2009). The other benefit of using a semi-log functional form is that it simplifies the consumer surplus calculation in comparison to other OLS specifications. In this case, consumer surplus per trip is simply the reciprocal of the travel cost coefficient (Creel and Loomis 1990). The natural log of the dependent variable also allows for nonlinearity in the demand function. To correct for heteroskedasiticity we use White's heteroscedastic-consistent standard errors. Because the fewest number of trips per year was (by definition) one, the log form meant that the lowest dependent variable was zero. For this reason, we tried the specification with and without a constant term.[5]

The final specification of our individual travel cost model is given in Equation (2).

$$lannualTrips_i = \beta_0 + \beta_1(TC_i) + \beta_2(Age_i) + \beta_3(Income_i) + \beta_4(Gender_i) + \beta_5(SeeWaves_i) + \beta_6(WatchSurf_i) + \beta_7(Surf_i) + \beta_8(FamFrnd_i) \quad (2)$$

where $lannualTrips_i$ is the natural log of the number of trips made by visitor i in one year, Age_i is an indicator variable representing individual i's age category[6], $Income_i$ is an indicator variable representing individual i's income category[7], $Gender_i$ is an indicator

[3] A significant ($p<0.05$) test statistic from the goodness-of-fit indicates that the Poisson model is inappropriate.

[4] All statistical estimations were performed in Stata 9.0 (StataCorp LP).

[5] In addition, an "opportunity cost" variable based on travel time was constructed. It was omitted, however, as travel time and travel cost were too highly correlated.

[6] The age categories were coded as 1: 18-25, 2: 26-29, 3: 30-39, 4: 40-55, 5: 56-70, and 6: 71+.

[7] The income categories were coded as 1: <$10k, 2: $10k-$29.9k, 3: $30k-$59.9k, 4: $60k-$89.9k, 5: $90k-$119.9k, 6: $120k-$200k, and 7: $200k+.

variable representing individual *i*'s gender[8], $SeeWaves_i$ is a dummy variable indicating whether individual *i* visited Mavericks to see the waves, $WatchSurf_i$ is a dummy variable indicating whether individual *i* visited Mavericks to watch other people surfing, $Surf_i$ is a dummy variable indicating whether individual *i* visited Mavericks to surf, and $FamFrnd_i$ is a dummy variable indicating whether individual *i* visited Mavericks to see family and friends. All other variables are as described in Equation (1). The reason "Surf Community" was dropped from the model because it was too highly correlated with other reasons to the visit the Mavericks surf area.

4.1 Population Projection Estimate

Total recreational visitor use is often quite difficult to calculate (English et al., 2002). This is particularly true in the case of an open-access amenity like the Mavericks surf area. In other such cases, like Loomis and Keske's (2009) analysis of the value of Pikes Peak in Colorado, they focus solely on individual consumer surplus and do not scale their findings to the general population. For this study, however, a headcount of beach goers was taken for each site visit, including the duration of time for which the headcount was valid (i.e. the amount of time spent surveying). For example, on February 7, 2009, a total of 56 people were surveyed during a three-hour period. In this same amount of time 450 individuals were at the beach. This allows for a very generalized estimation of the total number of visitors to the Mavericks surf area annually.

The ratio of survey participants to people on the beach was calculated and normalized by the number of hours the survey was conducted each day. This ratio was taken for each survey day. The average number of survey participants each hour was then multiplied by the average participant-to-population ratio, multiplied by 365 days per year and 8 hours per day. The 8 hours per day estimate is quite conservative, given that there are 10 hours of daylight in the winter months and 14 in the summer (US Navy, 2009).

$$V = \sum_{i=1,\ldots,d} P \Big/ d * t_i * \sum_{i=1,\ldots,d} \frac{H_i}{P_i} \Big/ d * days/year * hours/day \qquad (3)$$

where *V* is total annual visitors (includes double-counting); *i* is the respective survey day 1,…, *d* where *d* is the number of total survey days; *t* is the amount of time spent surveying on each day *i* in hours; *H* is the headcount taken on each survey day *i*; and *P* is the survey participants on each survey day *i*.

Using this equation, there are an estimated 421,431 visits to the Mavericks surf area annually. This is clearly a very general estimate using a simple scaling process. Yet there is no other visitation data for the Mavericks surf area. For reference, Half Moon Bay State Beach Park, several miles down the coast, is estimated to have an annual visitation of 990,406 (California State Parks, 2008). From conversations with Save the Waves Coalition staff and representatives from the Half Moon Bay Chamber of Commerce, it

[8] Female=1.

seems consistent that the Mavericks surf area should have considerably fewer visitors than the larger State Beach Park.

It is also important to note that this study is estimating the annual economic benefit of the Mavericks surf region, not the Mavericks surf contest. Our annual calculation of 421,431 does not include contest activity, as the 2009 holding period did not result in conditions adequate for the Mavericks surf contest. In the past, the Mavericks surf contest has drawn between 10,000 and 50,000 visitors in a single day, depending on the year and the source.[9] For a template of how to estimate the consumer surplus of a one-time event such as the Mavericks surf contest, see Appendix II.

5. Findings

The estimated demand functions are reported in Table 2. The first specification reports the demand function with no constant parameter and produces an R^2 of 0.54. As expected, the coefficient on travel cost is negative and highly significant. Also statistically significant are the demographic variables age and gender, at the 5% level. Another useful aspect of the semi-log model is the ease of interpreting the coefficients. The slope coefficient is the ratio of the proportionate change in annual trips to the absolute change in the explanatory variable. For example, an additional dollar added to the cost of travel decreases annual trips to the Mavericks region by 1.76%. Moving up an age category increases annual visits by 21.9%. Our results suggest that females, on average, will visit 84% more often than males.

Notably, if an individual visits Mavericks specifically to surf, this increases both annual trips and annual individual welfare. People who come to surf Mavericks and the nearby wave breaks including Ross's Cove will visit 447.8% (nearly 5 times) more often than any other user group.

For completeness we also include an estimate including the constant parameter in the demand equation, though this model does not "fit" as well as the first specification. Nonetheless, the coefficient for Travel Cost remains statistically significant at the 1% level.

[9] Surfing Magazine reports 10,000 spectators to the March 2, 2005 contest (the Mavericks website reported 30,000 for the same contest). The 2006 Mavericks event drew between 40,000 (Surfing Magazine) and 50,000 spectators (Maverick's website).

Table 2. Regression Results for Mavericks Demand Equation

	Dependent variable = *Log of Annual Trips* (no constant)		**Dependent variable= *Log of Annual Trips* (with constant)**	
Variable	**Coefficient**	***T* statistics**	**Coefficient**	***T* statistics**
Travel cost	-0.01764***	-2.68	-0.0207***	-3.08
Age	0.2193**	2.15	0.0908	0.66
Income	0.0979	1.17	0.0592	0.70
Gender	0.6112**	2.34	0.5195*	1.83
SeeWaves	0.4331	1.08	0.3072	0.77
WatchSurfing	0.4637	0.61	0.3622	0.52
ToSurf	1.7008***	4.52	1.5869***	4.04
FamilyFriends	0.0742	0.26	0.01871	0.06
Constant			0.7235	1.48
R-squared	0.5398		0.1179	
F statistic	24.14		4.23	
Probability (*F* statistic)	0.0000		0.0001	

*Indicates statistical significance at the 10% level, ** at the 5% level, *** at the 1% level.

The average visitor is estimated to receive $56.7 in consumer surplus per trip (calculated by the inverse of the coefficient for Travel Cost). With an estimated 421,431 visitors to the Mavericks surf area annually, the total annual net economic value to Mavericks visitors is estimated at $23.8 million. In addition, surfers are estimated to visit Mavericks near five times more often than non-surfers. This means that surfers accrue more benefit from the surf area than non-surfers over the year.

In comparison, Loomis and Keske (2009) find that hikers at Pike's Peak have a mean value of $31 per trip while Cog railway users at Pike's Peak have a mean value of $98 per trip. Loomis et al. (2009) fine that mean value of a round of golf in Colorado is $18 and the "few available downhill skiing studies have a consumer surplus of $33.50" (Loomis et al., 2009).

6. Conclusions

The Mavericks region of Half Moon Bay, California is famous for surf, whale watching, boating, and other recreational and ecotourism activities. This is the first study to quantify the benefits of visitors enjoying the natural amenities of the region, and the first study to evaluate the economic welfare that accrues to individuals associated with the sport of surfing. We develop an individual travel cost model to estimate the economic benefit for visiting the Mavericks surf area in Half Moon Bay, California. Results indicate that the average visitor to the area receives a benefit of $56.7 per trip. This amounts to a total annual economic benefit from the Mavericks region of $23.8 million.

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Appendix I. Survey Instruments

On-Site Survey

Please help us determine what the Mavericks surf break means to you in order to inform future development decisions that impact waves throughout the world. You can help by completing this survey about your experience travelling to Mavericks.

Please answer all questions as an individual (i.e. if you came to Mavericks with a group, answer for yourself only). No information provided will be individually attributed to the respondent.

1) Are you at least 18 years old? Y N

2) What is your zip code? _____

3) Tell us why you came to Mavericks: (circle all that apply)

A. To see the waves

B. To watch the surfing

C. To surf

D. To spend time with the surfing community

E. To spend time with family and friends

F. Other: _____

3a) Which of the above was the most important reason? A B C D E F

4) Did you fly to California or within California to travel here? Y N

4a) If "Y," what was the cost of your ticket? _____

5) Did you drive here?

5a) If "Y," what kind of vehicle do you drive? _____

5b) If "Y," is it a rental car? Y N

6) Is visiting Mavericks the primary reason for your trip to Half Moon Bay?

7) How many times have you traveled to Mavericks in the last month? _____

7a) In the last year? _____

8) Do you come to Half Moon Bay when there is no surf at Mavericks? Y N

9) By the time you leave, how many days will you have stayed in the area? _____

10) Where are you staying? (circle one) Hotel Motel With friends/relatives Camping Other _____

11) What was the most important factor in your choice of accommodations? (circle one)

Price Environmental-Concerns Location Other _____

12) Approximately how much do you think you spent per day on:

Lodging: $_____

Meals: $_____

Boat Tour: $_____

Other expenses: $ _____

13) Do you consider surfing an ecotourism activity? Why or why not? _____

14) What forms of marine recreation are you actively involved in? (circle all that apply)

Surfing Kayaking Fishing Waterskiing Scuba Sailing Other _____

Background Information

Note: The information you provide is confidential, and will only be used for demographic purposes.

15) Are you: (circle one) Male Female

16) What is your age range? (circle one)

18-25 26-29 30 – 39 40-55 56 – 70 71 or above

17) Do you travel outside the mainland US for the purpose of marine recreation? Y N

18) What is the highest level of education you completed? (circle one)

High School Some College Full College Degree

Some Graduate School Full Graduate Degree Prefer not to answer

19) Which range includes your gross annual income? (circle one)

Under $ 10k $10,000 - $ 29,999 $ 30,000 - $ 59,999 $ 60,000 - $ 89,999

$90,000 - $119,999 $120,000 – $200,000 More than $200,000 Prefer not to answer

20) Other comments ?

_____

Thank you very much for taking the time to complete this survey! If you would like to be available for further questions, or if you would like us to share the results of the study with you, please leave your email address below.

This study is sponsored by the Save the Waves Coalition.

Online Survey: Surfing Mavericks

We are looking for feedback regarding your experiences at Mavericks in order to better protect it and other waves throughout the world.

Privacy Statement: No information provided in this survey will be individually attributed to the respondent.

1) Are you at least 18 years old? Y N

2) How many times have you been to Mavericks in the last month? _____

3) Within the last year, how many times have you been to Mavericks?

A. 0-5 times

B. 5-10 times

C. 10-15 times

D. More than 15 times

4) Why do you visit Mavericks? (circle all that apply)

A. To see the waves

B. To watch the surfing

C. To surf

D. To spend time with the surfing community

E. To spend time with family and friends

F. Other: _____

4a) Which of the above is the most important reason? A B C D E F

5) What is your zip code? _____

6) When you go to Mavericks, do you also patron other services in Half Moon Bay (circle all that apply):

A. Restaurants

B. Shops

C. Accommodations

D. Other _____

7) What is surfing to you? (circle all that apply)

A. Recreation/pleasure

B. Exercise/workout

C. Ecotourism

D. Competition/profession

E. Other _____

8) What forms of marine recreation are you actively involved in? (circle all that apply)

Surfing Kayaking Fishing Waterskiing Scuba Sailing Other _____

***The same background information was collected for both the on-site and online surveys.

Appendix II. Template for Evaluating the Economic Benefit of a Surf Contest

This template applies the simpler *Zonal Travel Cost Approach* to estimating the economic benefit of a one-time surfing event. The zonal travel cost method is applied by collecting information on the number of visits to the site from different distances. Because the travel and time costs will increase with distance, this information allows the researcher to calculate the number of visits "purchased" at different "prices." This information is used to construct the demand function for the contest, and estimate the consumer surplus, or economic benefits, for the event.

Step 1: Define zones

The easiest way to define zones is by zip codes surrounding the contest site. This will facilitate the calculation of distance to the site later in the analysis. Determine how far people are likely to travel to the contest, and make a chronological list of those zip codes. Group zip codes into "zones" organized by concentric circles around the contest location.

Step 2: Visitors per zone

The second step is to collect information on the number of visitors from each zone. This is best accomplished by having as many volunteers as possible stand at the entrance of a contest site with the chronological list of those zip codes. They can survey visitors about their zip code, making tick marks by the appropriate zip code to be compiled later. Another option is to have volunteers walk around the contest and collect this information. Be sure that visitors do not respond twice to avoid double counting.

Step 3: Travel cost

Step 3 is to calculate the average round-trip travel distance and travel time to the site for each zone. People in Zone 1 will have the lowest travel cost, with all other zones having increasing travel costs. Next, using average cost per mile, one can calculate the travel cost per trip. A standard cost per mile for operating an automobile is available from AAA or other sources.

Step 4: Regression analysis

The fourth step is to estimate, using regression analysis, the equation that relates the number of event spectators to travel costs and other important variables. From this, one can estimate the demand function for the average visitor/spectator. The analysis might include demographic variables, such as age, income, gender, and education levels, using the average values for each zone. The simplest model includes only travel cost and spectators, i.e., Spectators = Constant – Coefficient*(Travel Cost).

Step 5: Demand equation

The fifth step is to construct the demand function for visits to the contest, using the results of the regression analysis. The first point on the demand curve is the total visitors to the site at current access costs (assuming there is no entry fee for the contest). The other points are found by estimating the number of visitors with different hypothetical entrance fees.

Step 6: Consumer surplus

The final step is to estimate the total economic benefit of the site to visitors by calculating the consumer surplus, or the area under the demand curve.