Welfare Estimates for Five Scenarios of Water Quality Change in Southern California

A Report from the Southern California Beach Valuation Project

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Introduction

The model of beach choice and activity developed by the Southern California Beach Valuation Project is intended to be the foundation upon which analysts can estimate the potential impact on the economic welfare of beach goers of water quality impairment and beach closures. The model can be used to estimate the loss or gain in consumer surplus that would result from a variety of scenarios that depict water quality and beach closures. In this report, we demonstrate the economic impact of five representative scenarios of beach water quality change. Each scenario examines water quality change or beach closures at a single beach. We examine the welfare impacts of water quality improvement and degradation. We also examine the welfare impact of a beach closure, in this case a closure at Huntington State Beach. We use the model to estimate closures that include a single day closure, a month long closure, and finally a closure that lasts the entire summer.

Three important caveats need to be considered when interpreting the welfare estimates presented below. First, the Beach Valuation Model was estimated separately for six different waves, where each wave models beach goer behavior for a two-month period. This approach accounts for seasonal variation in beach goer behavior and preferences. The results of the Beach Valuation Model, in fact, do indicate that both behavior and preferences differ across seasons. In the first two scenarios that follow, we examine the welfare impacts of water quality changes throughout the entire year. The final three scenarios, the summertime closure of Huntington State Beach, provide estimates for changes that affect one day and one month within the summer wave (July and August) and a three month closure that spans two waves (May/June and July/August). Estimates of welfare change for other waves would differ from those estimates provided below.

Second, an important strength of the Beach Valuation Model is that it accounts for the fact that beach goers have many options when deciding when and where to go to the beach[1]. Beach goers can choose to go to one of the more than fifty major beaches with public access in or near Los Angeles and Orange Counties. They may also choose to participate in activities that include swimming, sand-based activities or shopping. Finally, beach goers may simply choose to go to the beach, but not to swim, if water quality conditions are not suitable. The economic impact of water quality impairment, improvement, or even a closure depends importantly on the degree to which the change in water quality affects all of the beach goers' options. We focus on limited, marginal changes in water quality at beaches in southern California (that is water quality or beach access is impacted at only one beach). Hypothetical or real scenarios that involve water quality change or closure at more than one beach will have increasingly larger welfare impacts. The effects on welfare are non-linear; increasing the spatial extent of the quality change or closure increases the welfare impact at a rate greater than unity (i.e. the change is more than linear).

Finally, the welfare impacts that are estimated by the Beach Valuation model are sensitive to the value placed on travel time -- a large and important component of the total travel cost incurred by the beach goer. In the estimates below, we value travel time at fifty percent of the beach goers' wage rate. Elsewhere in the literature, travel time is valued at only one third of the wage. (In Appendix A, we also provide welfare estimates at zero, thirty-three and one hundred percent wage rate.) Because travel time is only part of the total travel cost, changing the valuation of travel time impacts the welfare estimates in a way that is less than linear, but still substantial.

The Value of a Beach Day

Much of the literature focuses on estimating the value of a recreational day, in our case a beach day. While the concept is widely applied, it is not without some ambiguity. The value of a beach day could bear a variety of meanings. At one end of the continuum of meanings is the value of being able to make a trip to a specific beach rather than not

[1] Most previous studies have not included these substitution possibilities when modeling the welfare impact of water quality change and beach closure, especially in Southern California.

being able to make a trip to any beach (i.e. the beach goer simply stays home). In reality, many substitution possibilities exist for the beach goer. The other end of the continuum of possible meanings is that the value under consideration represents the value of being able to make a trip to a specific beach rather than not being able to go to that beach while still being able to go to any other beach in the relevant choice set of beaches. Which interpretation of value is the most realistic depends on the particular circumstances at hand. In the Case of the American Trader oil spill at Huntington Beach in 1990, for example, most of the beaches over a long stretch of coastline were affected and the oil spill effectively shut down almost all beach recreation over quite a wide area, at least for a period of time. That would be more consistent with the first definition of the value of a beach day. On many other occasions, however, a closure may affect one or two individual beaches while leaving beach recreation elsewhere virtually unaffected. In that case, the second definition would be more realistic.

Focusing for the moment on the latter concept, the formula for this value is given by:

$$\text{Value of A Beach Day} = \frac{\sum_{i=1}^{n} \frac{\text{CS}_0 \text{-CS}_{\text{close i}}}{\text{trips}_{0,\text{i}}}}{n}$$

where there are n beaches, i represents an individual beach, CS_0 is the baseline consumer surplus enjoyed by all beach goers and $CS_{close\ i,}$ is the CS when beach i is closed but *all other* beaches are open. Our estimate of this value for beach visits in Southern California in the month of July amounts to \$11.17 when one uses a simple (unweighted) arithmetic average across all beaches, and \$11.21 when one takes a weighted average across all beaches using the total number of trips to each beach in the baseline case as the weight.

This value is lower than many of the values for beach visits in Southern California estimated by previous analyses (see Table 1). But those estimates typically involved single-site demand models rather than multi-site demand models and therefore did not account adequately for the inter-site substitution possibilities among the beaches of Southern California which are captured in our Beach Valuation Model.

In the remaining welfare estimates, presented below, we present estimates for the total change in consumer surplus, compared to a baseline, rather than the consumer's surplus per trip. These changes in consumer's surplus are calculated for various beach closure and water quality change scenarios, and the change is summed over all potential beach goers living in the four Southern California counties covered by our study. We also indicate the change in the total number of beach trips taken by beach goers in these counties as a result of the beach impact scenario. These estimates of the total welfare impact are accurate reflections of the non-market economic impact of these scenarios. These total consumer surplus estimates reflect the total benefit or cost of the scenario, which is the figure that is most often required when making assessments about the economic impact of a policy or natural resources damage event.

Table 1: Estimates of the Consumer Surplus Value of Beach Visits in California[2]

	US$(1990)	**US$ (2000)**
Cabrillo-Long Beach[1]	$8.16	$10.98
Orange County Beaches[2]	$15.00	$20.18
Santa Monica[1]	$18.36	$24.71
Pismo State Beach[3]	$26.20	$35.26
Leo Carillo State Beach[1]	$51.94	$69.91
San Onofre State Beach[3]	$57.31	$77.14
San Diego[3]	$60.79	$81.82

Source: Chapman and Hanemann (2001). The data are extracted from 1) Leeworthy and Wiley (1993) 2) Hanemann (1997) and 3) Leeworthy (1995).

Consumer Surplus/Day	**US$ (2001)**			
Individual Surplus/Day	Carpinteria	Encinitas	San Clemente	Solana Beach
Method 1	$20.48	$18.84	$25.70	$14.58
Method 2	$24.43	$22.17	$30.58	$17.35

Source: Philip King, The Economic Analysis of Beach Spending and the Recreational Benefits of Beaches in the City of San Clemente, 2001. Note: Method 1 - dependent variable is a discrete random variable, CS calculated as the sum of a series of rectangles, each one day wide, touching the demand curve at its upper right corner. Method 2 - CS calculated as the sum of a rectangle for the area under the curve between zero and one, and the definite integral for the area between one and the average number of trips.

[2] From Pendleton (2004).

Estimating the Economic Impact of Beach Water Quality Change in Southern California: Five Scenarios

The Beach Valuation model can estimate the total change in beach goer welfare (consumer surplus) for a change in access to beaches or a change in beach water quality. For the purposes of exposition, we explore the welfare impact on beach goers of five scenarios. The five scenarios are designed to demonstrate the way in which the model estimates improvements in beach water quality, degradation of beach water quality, and beach closures of varying lengths of time. These scenarios are hypothetical. The results of the welfare analyses are summarized in Table 2. Additionally, we provide estimates for the impact that these scenarios would have on the total number of beach visits taken. A discussion of the results follows.

SCENARIO 1: An Improvement In Beach Water Quality

Malibu Surfrider Beach Water Quality Improves by One HTB Letter Grade

In 2000, Malibu Surfrider had a low water quality rating of approximately C (2.13 on a scale of 0 to 4). This hypothetical scenario explores the impact of improving water quality at Malibu, perhaps by reducing sewage effluent inputs into Malibu Creek, so that water quality improves to an average annual grade of B (3.0/4.0). All other sites remain unchanged.

An improvement in water quality at Malibu Surfrider Beach has two major impacts on beach goers. First, the number of trips taken to Surfrider beach increases by 1,538 visits over the course of the year. Most new visits are made by residents of Los Angeles County, the closest county. The second major impact of an improvement in water quality is that annual consumer surplus of beach goers improves by more than $140,000, the majority of these benefits accrue to local residents (i.e. residents of Los Angeles County).

SCENARIO 2: A Degradation of Beach Water Quality

Zuma Beach Water Degrades to an HTB Letter Grade of F

In 2000, Zuma Beach enjoyed a high level of water quality, with an annual HTB grades of A/A+. Zuma Beach also is a popular beach among beach goers. The adjacent beaches also have very high quality ratings of A/A+ and A/A-. This hypothetical scenario explores the potential impact on beach goers that would result if Zuma Beach water quality declined to a grade of F. All other sites remain unchanged.

A dramatic decline in beach water quality at Zuma Beach would have serious consequences for beach goers' welfare. Beach attendance at Zuma Beach would decline by more than 57,000 visitors resulting in a loss of beach goer welfare of over $5.2 million. Most of the welfare and attendance impacts are borne by beach goers from Los Angeles County.

SCENARIOS 3-5: Beach Closures

Huntington State Beach (HSB) Closes for One Day, One Month, and One Summer (June – August)

During 2000, Huntington State Beach (HSB) had numerous days with poor water quality, ranging from a D to an A-; overall the annual average grade for Huntington State Beach was a B-/C+. This is in contrast to the adjacent beach areas, Huntington City Beach and Santa Ana River, which received higher grades (average A-/B+). This hypothetical scenario explores the potential impact that would results from beach closures at Huntington State Beach for three duration lengths: one day in July, one month (July), and one summer season (June, July, and August). All other sites remain unchanged.

First, the model does not allow for temporal substitution. That is, the model assumes site choice decisions are made each day independently of decisions and conditions on other days. As a result, the welfare impact for a one month closure is 31 times the impacts of a one day closure. We estimate that a one day closure at Huntington State Beach, in July, would result in a loss of more than 1,200 beach visits and a welfare loss of over $100,000. A month long closure during July would result in a loss of over 38,000 beach visits and a welfare impact of more than $3.5 million. Huntington State Beach is popular among beach goers from the four southern California counties considered. As a result, the impacts on attendance and beach goer welfare are spread across the four county area. Orange County suffers the greatest impacts, but the economic impacts to beach goers from Los Angeles, San Bernardino, and Riverside Counties are substantial.

A season long beach closure requires that we change water quality during two different waves (remember that a wave consists of a two month period and we allow beach goer preferences to differ among waves). The season long closure consists of the following days of closure: June (30 days), July (31 days), and August (31 days). Such a closure would result in decline in attendance of more than 100,000 visits and a loss in beach goer welfare of over $9 million. Note that the welfare impact is not a simple linear expansion of the value of a daily closure in July because the welfare impacts of a closure in the May/June wave are less than that in July/August.

Table 2 Total Welfare Impacts, Consumer Surplus Change

SCENARIO	Los Angeles	Orange	Riverside	San Bernardino	Total
1. Malibu Improves (C to B)	$132,572	$1,731	$1,816	$4,445	$140,564
2. Zuma Degrades (A to F)	-$4,873,739	-$80,330	-$95,982	-$222,527	-$5,272,578
3. HSB Closes 1 Day	-$44,232	-$48,837	-$10,998	-$11,590	-$115,657
4. HSB Closes 1 Month (July)	-$1,371,198	-$1,513,958	-$340,929	-$359,284	-$3,585,369
5. HSB Closes 1 summer (June, July, and August)	-$3,531,108	-$3,969,551	-$877,816	-$925,711	-$9,304,186

Table 3 Total Change in Trips for All Beach Goers

	COUNTY OF RESIDENCE				
SCENARIO	Los Angeles	Orange	Riverside	San Bernardino	Total
1. Malibu Improves (C to B)	1,450	19	20	49	1,538
2. Zuma Degrades (A to F)	-53,118	-870	-1,054	-2,447	-57,489
3. HSB Closes 1 Day	-478	-523	-120	-127	-1,248
4. HSB Closes 1 Month (July)	-14,821	-16,224	-3,724	-3,930	-38,699
5. HSB Closes 1 summer (June, July, and August)	-38,256	-42,658	-9,605	-10,143	-100,662

It is important to note here that the data provided in Tables 2 and 3 cannot be used to calculate the value of a beach day. Table 2 provides estimates of total welfare gain or loss, by county, for the five scenarios and Table 3 provides estimates of the change in total number of trips taken, also by county. For any one "hypothetical" beach visitor, the welfare impact of a degradation in quality at one of the many beaches in southern California is considerably different than the welfare impact for a beach goer who normally would have gone to the beach in question.[3]

It also is important to note that the welfare estimates given in Table 2 depend importantly on the estimated value of travel time. In the analysis above, we estimate the value of a beach goers' time at fifty percent of their wage rate. Table 4 demonstrates the sensitivity of welfare impacts to different wage rates using the case of Scenario 1 in which the average annual Heal the Bay grade improves from a C to a B. The literature does not provide explicit guidance on the appropriate percentage of wage rate that should be used in the valuation of time. It is important that the analyst understand that estimates of welfare change provided by the beach valuation model reflect a value of time measured at fifty percent of the wage rate; the choice of other time values would change these estimates.

[3] A brief technical memo on the calculation of per trip welfare estimates from random utility models is forthcoming by Michael Hanemann.

Table 4: Sensitivity of Welfare Estimates to Value of Travel Time: Scenario 1 (Malibu Improves from C to B, Los Angeles County Beach Goers Only)

Percent of Wage Rate Used	Welfare Impact (Los Angeles County)
0%	$24,463
33%	$93,603
50%	$132,572
100%	$252,812

Conclusion

Even minor changes in water quality at beaches in Southern California can generate large economic impacts. A day-long closure at Huntington Beach would lead to a loss of recreational welfare well in excess of $100,000. Similarly, a minor improvement in beach water quality at Malibu, from an average grade of C to an average grade of A would generate approximately $140,000 in welfare gains for beach goers. More dramatic changes in beach water quality yield even more substantial welfare impacts. Dramatic declines in water quality at clean beaches, like Zuma Beach, would lead to the loss of millions of dollars in beach goer welfare (in this case more than $5 million); a summer time closure of swimming waters at Huntington State Beach would result in even greater losses (we estimate a loss of over $9 million in beach goer welfare). These values do not include lost expenditures, the subject of another report.

The Southern California Beach Valuation model is a powerful tool that will allow policy makers to explore the potential economic impacts of changes in water quality and beach access in Southern California. Great care has been taken to make sure that the model generates welfare estimates that are the most accurate that can be achieved through current methods of environmental valuation. The welfare model is based on an economic model of site choice that has been designed to accurately reflect beach choices by different types of users and over different seasons. Additionally, the model was estimated using the most comprehensive set of beach characteristics (beach attributes) ever collected for this purpose. Despite our efforts to provide the public with the most accurate welfare estimates of the impacts of water quality changes, we urge the user of the model to check back for improvements and refinements in the model. The field of environmental economics is one that is constantly advancing. We have collected our data in a way that will allow us to refine our model based on these advancements.

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