Valuing Beach Recreation Lost in Environmental Accidents

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Abstract: This paper reviews methods that can be used to estimate the loss in use value associated with saltwater beach recreation in the case of an environmental accident, such as an oil spill. Particular attention is focused on methods for verifying beach attendance data and on transferring benefit estimates from other locales. The paper first reviews methods for estimating what reported attendance might have been had the accident not occurred. The next issue considered is how to verify reported attendance data and how to correct it when systematic inaccuracies are found. The paper then turns to the question of valuing a beach visit and reviews the relevant empirical literature.

I. INTRODUCTION

It is common that environmental accidents temporarily restrict ocean recreation opportunities. The *Amoco Cadiz* oil spill in 1978 damaged beaches in Brittany (Brown et al, 1983). The monetary value of lost beach recreation was part of the damages assessed against Amoco. In 1990, the *American Trader* oil tanker spilled oil just off Huntington Beach, immediately south of Los Angeles, closing some of the most visited beaches in the U.S. for a period of weeks or more.[1] Again, the value of lost beach recreation was a major factor in assessing damages against those responsible for the spill. In the late 1990s several beaches in Santa Barbara County, California were closed to swimming and other water contact sports for periods of several weeks. In this case the cause was bacterial contamination from storm runoff through creeks. In this case, estimating the value of value lost beach recreation would be an important step in formulating policy concerning the abatement of waterborne bacterial loads.

Although much has been done to improve methods for valuing recreation and other nonmarket environmental goods,[2] there is little published on the practical steps needed to generate an estimate of lost recreation value due to a closure. The purpose of this paper is to detail some of the issues that must be faced in generating damage estimates.

The typical situation in the case of an accident that affects beach use is that attendance drops, possibly to zero, during the affected period. After the beach reopens, the beach experience may be degraded for those who do attend. Furthermore, not all beach visits are the same. The second visit in a week for an individual is probably not worth as much as the first visit. Visits of different duration may be valued differently -- a two hour visit is not equivalent to two one hour visits. Conceptually, the correct way to view the value of lost beach visits is to first measure the surplus loss to an individual and then aggregate over the population of individuals. This can be very difficult.

Practically speaking, the typical way of viewing damages is that all visits have the same value, and that total damage is the product of price (average value) and quantity (number of visits lost). The relevant academic literature has focused almost exclusively on the price component of this product, i.e., on valuation, and paid little attention to the quantity component. As shown shortly, however, estimating quantity also presents practical and conceptual challenges. One must attempt to estimate how many visits would have been made if the closure had not occurred. Inevitably, this requires the use of reported data on beach visitation for periods when the beach was open. As emphasized later, in cases where no admission fee or parking fee is charged and access is largely unrestricted, the task of measuring the number of visits is very difficult. In these situations the quality of reported visitation data is naturally open to question, and assessing the accuracy of visitation data becomes an important part of the analysis.

II. BEACH ATTENDANCE

The first question to ask is how much would the beach in question have been used but for the accident? This is not an easy question to answer quantitatively. There are three time periods to be concerned about: the period when the beach is officially closed, for clean-up purposes or for public health reasons (closure period), the period when the beach is open but the experience is degraded because there is still evidence of pollution (physically degraded period), and the period when the beach is physically clean yet the memory of the accident is fresh enough that the quality of the experience may be somewhat degraded (perceptually degraded period).

Normally, researchers can only deal with lost attendance during beach closure or possibly in the period immediately following beach closure. Because daily beach attendance fluctuates dramatically and for a large variety of reasons -- an interesting sports broadcast on local TV can dramatically reduce attendance -- it is hard enough to estimate what the attendance might have been if the beach were not closed. Although it is desirable to estimate lost attendance during the physically and perceptually degraded periods, that is often not possible.

To estimate beach attendance but for the accident, one must answer two basic questions: what would reported attendance have been but for the accident, and does actual attendance differ systematically from reported attendance? As will be discussed later, these are two very different questions, and the second question regarding data accuracy can be very important. For beaches with controlled access, such as through parking lots and entrance booths, estimating actual attendance on any given day is straightforward and generally accurate. However, many beaches do not have limited access points but are bounded by a boardwalk or path adjacent to shops and other urban amenities. Measuring the number of beach visits at such beaches is difficult and is subject to more error.

Most well attended beaches maintain attendance records, often daily. In California, this applies to beaches at State Parks as well as many municipal beaches. To estimate the damage from an accident, one must estimate (1) what reported attendance would have been had the accident not occurred and (2) how much reported attendance estimates differ from actual attendance. We consider these two issues below.

A. "But For" Reported Attendance

The first question, "What would reported beach attendance have been but for the accident?" is best viewed as an econometric question. Given daily, or perhaps weekly or monthly, data on attendance covering a substantial historic period, a model of beach attendance can be estimated. This model can then be used to simulate the counterfactual of the affected beach being open.

Conceptually, beach attendance is complex. Whether someone goes to the beach depends on what other recreation opportunities are available, including sports events on and off television, weather, at the beach and elsewhere, the opportunity cost of the visit, and other factors including how many recent opportunities there have been to attend the beach. Although it is possible that a structural model of beach attendance could be constructed, it is not easy to represent the beach choice problem, particularly when there are a number of close substitutes. A reduced-form time-series approach is easiest to implement and probably most practical.

In constructing a model of beach attendance at southern Los Angeles area beaches in the context of the *American Trader* oil spill, Paul Ruud estimated a vector autoregressive (VAR) model of attendance: attendance is affected by contemporaneous variables, such as weather, day of the week, and season, but also lagged attendance at the beach and at other beaches. VAR models are commonly used in macroeconomic forecasting. Including lagged attendance reflects the fact that errors from examining only contemporaneous variables will tend to be temporally autocorrelated (Ruud, 1994; Dunford, 1999). All other things being equal, if yesterday was a day that attracted a large number of beach visitors, then it is likely that today will also attract many beach visitors.

One problem with using a VAR model to simulate the counterfactual is that observations on lagged beach visits, absent the accident, are unavailable. Thus it is important to try (a) to include as many appropriate contemporaneous variables as possible; and (b) to use lagged attendance at beaches outside of the accident area rather than within the accident area.[3] This may not always be feasible however. The less desirable alternative, of using forecast attendance at the study site and lagging it for subsequent forecasting, can cause errors to be compounded.[4]

As was mentioned earlier, another issue concerns the duration of the damage period. This is not much of an issue when the beach is completely closed. But in other cases the beach may be closed only to some activities; e.g., swimming and surfing. Also, after the beach opens the quality of a visit may be degraded, or people may not be immediately aware that it has reopened. Clearly, there is some period of time immediately following actual closure where one can expect attendance to be reduced.

B. Correcting Reported Attendance

Reported beach attendance may not correspond to actual beach attendance, and actual beach attendance clearly is what is needed to estimate damages. Thus the second step, and the one considered in this section, is to identify and correct for any systematic discrepancy between reported and actual beach visitation.

In this regard, we can separate beaches into two types: those with limited access and those without limited access. Limited access beaches have restricted entry points where one can observe entry and exit. Open access beaches on the other hand are freely accessible, so observing entry and exit is difficult at best. Each type of beach requires a different approach for verifying and, if necessary, correcting reported attendance.

1. Limited Access Beaches. For limited access beaches, parking is often monitored to generate attendance estimates. For State Beaches in the Los Angeles area, authorities generally charge for parking and thus have fairly accurate counts of the number of cars "using" a particular beach. Authorities make assumptions regarding the average number of occupants per vehicle as well as the average ratio of "walk-ins" to vehicles. To the extent that assumptions about these ratios and averages are based on observation, this is a reasonably accurate and cost-effective way to estimate attendance. Problems arise when walk-ins and automobiles are not highly correlated. Further problems arise from people who walk along a beach, since it is difficult to exclude entry near the shoreline. In assessing the accuracy of reported attendance at limited access beaches, it is important to verify that the car counts are accurate, that the assumed occupancy rate is accurate and that the ratio of "walk-ins" to automobiles is accurate. Accuracy can be judged by random sampling of individuals on the beach or of individuals arriving at the beach.[5] If the underlying assumptions are not accurate, the analyst can correct reported attendance figures appropriately.

2. Open Access Beaches. Attendance at open access beaches is more difficult for authorities to measure and more difficult for the analyst to verify. This was illustrated in the controversy over the National Park Service's estimate of participation in the "Million Man March" on the Mall in Washington on October 16, 1995. The Park Service estimated attendance at 400,000, whereas the organizers estimated attendance at 2 million. Subsequent analysis of aerial photos by Boston University placed the figure between 700,000 and one million (Daly and Harris, 1995). It is not easy to estimate the size of crowds.

This suggests that aerial photos are one reliable way to estimate the number of people over a large area.[6] However, aerial photos are prohibitively expensive as a way to generate regular estimates of attendance. Newport Beach, California asks lifeguards to estimate attendance at different points in time during a day and from these estimates, beach attendance is computed. Huntington City Beach, California, another open access beach, also uses lifeguards to estimate attendance, though relying more heavily on car counts in parking lots (Chapman et al, 1998).

One could take aerial photos of the beach at different points in time during a day and count the number of people in the photos. A problem, however, is that aerial photos only give the stock of people at a point in time, not the number of visits. One can, however, estimate the number of distinct visits by combining information on the stock of visitors at various points in time, e.g., from aerial photo counts, with information on the duration of visits. The basic idea is simple. If one knows the stock of people on the beach as a function of time throughout the day, the total number of “person hours” at the beach can be computed by integrating this function over the day. Dividing person hours by the average duration of a visit then gives the number of separate visits.

To illustrate the procedure, we discuss below our estimates of beach visitation at Newport Beach and Huntington City Beach over several days in the Spring of 1995. Because aerial photographs are expensive, we carried out the analysis for only five days, three weekend days and two weekdays, and present results from two days in what follows. The procedure is divided into two parts: establishing the number of people on the beach at each time during a day, and converting the estimated time profile of this stock of visitors to an estimate of visits. The first task is accomplished with aerial photographs. The second is accomplished by estimating average visit duration with data from a survey of arrival and departure times.

a. Stock of People on the Beach. A major component of computing the actual attendance is an estimate of the number of people physically on the beach, bikepath, pier, parking area, water and playgrounds at any point in time during a day: B(t).[7] Our approach was to take aerial photos at three times during the day, 11 a.m., 1:30 p.m. and 4 p.m. for the entire beach in question. We assumed zero attendance at 6 a.m. (before sunrise) and did visual counts of attendance at several other points in the early morning. Manual night counts of attendance were also conducted for times after 6:00 p.m.

We were unsure exactly when the peak beach attendance occurred during the day. The counts from the 1:30 p.m. photos were higher than the 11 a.m. or 4 p.m. photos, suggesting the peak occurred close to 1:30 p.m. We assumed that B(t) was constant at the 1:30 value between 12:30 and 2:30 p.m. Linear interpolation was used for other times during the day to produce an estimate of B(t) for all t between 6 a.m. and 6 p.m. The last aerial photos were taken at approximately 4 p.m. The night counts allowed us to estimate beach attendance at 6pm.

b. Duration of Beach Visits. Having established the time profile of the stock of visitors, we need an estimate of the duration of beach visits in order to compute the number of visits. To compute duration, it is necessary to survey visitors. For instance, surveyors can randomly intercept individuals on the beach, ask their arrival time, expected departure time, and expectations about temporarily leaving the beach during their visit. From this, it is straightforward to compute the duration of their beach visit. However, the goal is to estimate the average visit duration over the population of beach visitors and this sampling procedure tends to over-sample visitors who make longer visits. For any sampling rate, a visitor who stays at the beach all day is far more likely to be surveyed than someone who is only there 20 minutes.

Both types of visits count equally as “visits” for the purpose of estimating lost recreation value.[8]

To correct for over-sampling of long duration trips, each observation in the sample must be weighted by the probability of being sampled.[9] For the i^{th} member of the sample, let a_i denote the arrival time, x_i the gross duration of the visit (including time spent away from the beach), and r_i the time spent away from the beach in restaurants and shops. The net duration of i’s visit, m_i, is simply $x_i - r_i$. Further, let S(t) be the sampling rate (people per hour) at time t and recall that B(t) is the number of people on the beach at time t. Define the sampling proportion as the ratio of these two, s(t)=S(t)/B(t), the fraction of people on the beach sampled per hour at time t.

Given that a respondent is on the beach, the probability, $?_i$, that visitor i will be sampled is proportional to the fraction of beach visitors are sampled during the i’s visit:

$$?_i \propto \int_{a_i}^{a_i+x_i} s(t)\, dt \equiv \delta_i \qquad (1)$$

Eqn. 1 is simple to interpret.[10] Suppose an individual is at the beach for four hours and suppose also that the sampling rate is constant at 1% per hour over that period, which would be true if the number of people on the beach is constant and the number of people sampled per hour is constant. If we continually sample 1% of the people on the beach every hour, then the integral in Eqn. (1) is simply the duration of the visit times the sampling rate. In this case (constant sampling rate) the probability that i is sampled is proportional to the duration of i’s visit.[11]

This is a problem in sampling theory, where the sample is not random. The goal is to determine the mean duration of the entire population of beach visits. Let f(x) be the unknown population density of visit durations (x) and g(x) the known sampling distribution. We seek to estimate the mean visit duration based on the population density, which we denote by . Utilizing the fact that sampling is proportional to visit duration and the number of visitors on the beach, as discussed in the context of Eqn. (1), this implies (Cox, 1968) that

$$g(x) = [\delta(x)/\Delta]f(x) \qquad (2)$$

where Δ is a constant of proportionality that makes g integrate to one and $\delta(x)$ is the weight associated with a visit of duration x, developed for the discrete case in eqn. (1). Thus 1/ is equal to the expectation of 1/ (x) with respect to the sampling distribution, g. Rearranging Eqn. (2), multiplying both sides by x and integrating, we obtain

$$_g[x \quad / \quad (x)] = E_f[x] \qquad (3)$$

where E_g and E_f are expectations with respect to the distributions g and f, respectively. Unbiased estimates of and , $^\wedge$ and $^\wedge$, can be obtained from a sample of size N:

$$1/^\wedge = (1/N)\sum_i(1/\delta_i). \qquad (4)$$

$$^\wedge = (1/N)\sum_i(^\wedge/\delta_i)m_i. \qquad (5)$$

To implement this procedure we calculated the sampling rate on an hourly basis for each beach. For example, for Newport Beach during the period 10 a.m.-

-11 a.m., we divided the number of surveys executed during that hour by the average number of people on the beach during the hour. This sampling rate was considered to be constant over the hour when calculating δ in Eqn. 1 for surveys completed during that hour. The average durations of visits at the beaches surveyed are reported in Table 1.

c. Estimating Visitation. Given an estimate of the average duration of a beach visit (m), and the time profile of the stock of people on the beach at any given time during the day, it is straightforward to compute the number of distinct beach-visits. The integral under B(t) from 6 a.m. to 6 p.m. gives the number of person-hours spent on the beach during the day. The estimated number of daytime beach visits is simply

$$V_D = \Omega_D/m \qquad (6)$$

This is, of course, only an estimate of day visits. To be complete, one should spot check night attendance.

Table 1 shows the results of this calculation for Newport Beach and Huntington City Beach, two beaches south of Los Angeles, for two days in 1995. Table 1 also shows attendance figures reported by the government agencies that operate those beaches, using the lifeguard count methods described earlier. Evidently, the lifeguard counts significantly overstate actual attendance. On the busiest day at Newport Beach, reported visitation exceeds the estimate based on aerial photos by a factor of almost five.[12]

III VALUATION METHODS

There are two general approaches to monetizing the value of lost beach visits. One is to use what has become known as benefits transfer. This involves surveying the literature on empirical analyses of the value of similar goods. Based on this literature, an inference is drawn about the value of a lost recreation day at the beach being considered.

The second approach is to conduct a valuation study at the beach subject to closure. This can be expensive but has the obvious advantage of applying directly to the beach of interest. There are two basic empirical methods for valuing beach recreation, contingent valuation and travel cost.[13] Contingent valuation involves surveying beach visitors. These surveys include questions such as “If, in order to maintain beach quality, it became necessary to institute a fee of $9 per day to visit this beach, would you continue to visit?” By comparing responses to such questions with characteristics of the respondent and varying the reservation fee proposed, estimates of willingness to pay for a beach visit can be deduced, at least in principal.

A second empirical approach to valuing beach recreation involves determining how travel costs affect beach visits This is a widely used method, dating back to the 1940s. If one can observe the cost an individual bears when making a beach visit, one may infer that the visit must have been worth at least as much as the cost. Thus, travel cost plays the role of a price, and demand may be estimated. While the basic premise is valid, the travel cost method is not without problems. At least three issues arise in implementing the travel cost method for determining the value of lost beach recreation. One concerns the sampling frame. Should visitors to the beach be sampled, the common approach, or should the population of possible visitors be sampled, a much more costly but less problematic approach (see Hausman et al, 1995). Second, how should one deal with the value of travel time? Certainly it is related to an individual's wage, but does it equal the wage?[14] What about children and the unemployed? A third issue concerns the treatment of visit. Considering visit duration explicitly is important because visits of different length probably are not are equally valuable, and those travelling a long distance to the beach are likely to stay longer,

These problems are particularly thorny in the case of multi-day and multi-purpose trips, where it becomes difficult to associate specific components of travel cost to specific recreation activities. For instance, if someone travels from the U.S. to Barcelona for three weeks, visiting beaches, museums and enjoying Spanish food, art and culture, it may be difficult to measure the value of a beach day in Barcelona based on total travel expenditures. The travel cost method is better suited to single purpose trips of short duration.

An important issue in any recreation valuation study is the treatment of substitutes. If a perfect substitute beach exists, then the damage from being excluded from the closed beach cannot exceed the travel cost to the substitute. Even if the alternative beach is not a perfect substitute, it can still limit surplus loss from the closed beach. However, estimating demand for several sites that are imperfect substitutes is difficult.

A further complication is temporal substitution.[15] Temporary closure may cause a beach visit to be deferred by several weeks, but not lost permanently. It is unlikely that deferred visits and permanently lost visits are equally costly. Put differently, valuation studies usually consider only the permanent addition or permanent subtraction of beach recreation opportunities. An accident causes temporary loss of recreation opportunities, however, and consumers may respond by substituting across time, postponing visits until the beach reopens. To what extent do consumers substitute across time? If the delayed beach visit is a perfect substitute, then there is no loss from the temporary closure. It is likely that visits at different points in time are only imperfect substitutes, however, which brings us back to the difficult estimation issues associated with spatial substitution.

An additional concern is the loss associated with degraded beach visits. If the quality of a beach visit can be quantified, e.g., if pollution levels are observed, then it may be possible to estimate the surplus loss from a degraded visit. Such quality-considerations have been introduced in some studies, as noted shortly, but not in the context of environmental accidents.[16]

A. Summary of Other Studies.

An inexpensive approach to estimating the value of a lost beach visit is to transfer an estimate of the value of a lost visit prepared for another context to the beach of interest. Basically, one surveys the literature on beach recreation and generates a best estimate of the value of a visit at the beach in question. To assist in using benefits transfer, we provide a review of benefits estimates for saltwater beach recreation.[17]

A word of caution is in order in conducting benefits transfer. One must be aware of the nature of the good being valued. With a beach visit, is this a summer visit, a winter visit, a day trip or a multi-day trip? Is the visit primarily to use the beach or to use the water? Should the analysis include boaters, surfers, whale watchers? Clearly, these questions must be addressed when transferring benefit estimates from elsewhere.

There appear to be thirteen relevant studies of the value of saltwater beach recreation. All use either the contingent valuation (CV) or travel cost approach. A number of other studies of water recreation or the value of water quality improvements at recreation areas were also identified. However, they are less useful for determining the value of a lost saltwater beach recreation day for residents.[18]

Table 2 summarizes the values estimated for a beach day visit in the studies examined. The table shows the values taken directly from the studies (column 2) and values inflated to common (1990) dollars using the consumer price index. When reviewing the Table, keep in mind that each of these studies was done in a different context so they may not be directly comparable.

The majority of these studies used the CV method. Although quality is always an issue in economic analysis, this is particularly important with CV studies, because the nature of the survey instrument can significantly shape the results obtained. To provide guidance as to the validity of the CV method and to outline proper protocols to use in CV studies, the U.S. National Oceanic and Atmospheric Administration (NOAA) convened a "blue-ribbon" panel of experts to conduct an independent review of these issues (the "NOAA Panel"). The panel, convened in 1993, concluded that CV can provide useful information, but surveys should be constructed with considerable care.[19] These findings were subsequently embodied in NOAA regulations on the conduct on Natural Resource Damage Assessments.[20] The guidelines are detailed, and include such general recommendations as using referenda rather than open-ended questions, using personal rather than mail surveys and carefully pretesting the survey instrument. Most of the CV studies reviewed here predate these guidelines. The state-of-the-art of CV has evolved considerably over the last two decades.

In order to shed light on the context in which these studies were conducted, as well as the strengths and weaknesses of the methods used, we now review some of these studies below.

B. Details of Selected Studies

1. Bell and Leeworthy. In 1986, Frederick W. Bell and Vernon R. Leeworthy published a study on the value of Florida beaches . The authors were interested

in the value of a day visit to the beach and the direct and indirect economic effects from beach use for both the resident population and tourists from out-of-state.

The data for their study came from a statewide survey conducted in March, 1984 concerning beach use in the state during the previous twelve months. Information was obtained on the number of times the respondent had visited the beach, aggregate expenditures involved in visiting beaches, as well as characteristics of the individual -- information necessary for travel cost analysis and contingent valuation.

The travel cost method for valuing recreation resources is well known and widely used. However, Bell and Leeworthy did not examine travel costs, but rather focus on total direct expenditures associated with recreating. To draw the distinction, they included expenditures on meals and lodging, expenditures that may in fact be part of the recreation experience rather than the cost of making a trip. They also excluded the value of time associated with traveling to the recreation site. Another difficulty with their approach is that the visitation rates and beach expenditures used in estimation are not modeled in a way that takes specific attributes of the beach visited into account

To obtain a CV estimate of the value of a beach visit, the authors asked the following question:

> Because of beach erosion and other beach related problems, suppose it became necessary for beach users to agree to buy an annual pass which allows you to visit all public beaches in Florida. The money collected would pay for preservation of the beach. What is the maximum you would be willing to pay for the annual beach pass, in addition to any current beach fees?

This yields a CV estimate of the value of a lost beach day. The authors, apparently concerned that responses to this CV question were low, adopted a multiplicative adjustment factor of 3.003 drawn from a study of goose hunting permits done by Bishop and Heberlein (1979). This adjustment factor was intended to adjust for a supposed downward bias in responses to willingness-to-pay questions relative to what would be expected in an actual market. While there is a good deal of evidence in the literature that willingness-to-pay is less than willingness-to-accept compensation, there is no consensus on the appropriate adjustment. In fact, the difference is large in some studies and small or negligible in others.[21]

2. McConnell (Rhode Island) In 1974, Kenneth E. McConnell surveyed visitors at Rhode Island beaches in order to measure willingness-to-pay for beach visits and the effect of crowding.[22] A series of questions was posed to the beach-goer involving a hypothetical price and whether he or she "would come to the particular beach on the particular day for that price?" with the suggested price sequentially incremented by $0.50. Thus a series of yes/no responses is collected, resulting in a CV estimate of maximum willingness-to-pay. Other information was collected in the surveys, including family income and the number of visits per season. Hourly temperature and daily attendance at the beach were also recorded.

McConnell regressed these individual willingness to pay responses against family income, congestion at the beach, temperature at the beach, and per season visits of the individual, obtaining the following equation:

$$\ln w = -4.7 + \underset{(1.0)}{0.00001\, y} - \underset{(2.5)}{0.0025\, q} + \underset{(2.5)}{0.076\, t} - \underset{(9.3)}{0.058\, x} \qquad (7)$$

where t-statistics are in parentheses and w is per-capita surplus or willingness to pay ($/person), y is family income ($/year), q is congestion (attendance/acre), t is temperature (^{o}F), and x is visits of the ith individual to the beach.[23] Note that while the coefficient on income is not significant, the coefficients of the other variables are significant at conventional levels. The R^2 for the estimated equation is 0.29.

While McConnell does not report enough information to calculate the mean value of a beach-day, one can obtain estimates from what is reported. Since congestion is an externality, he first computes the socially optimal level of congestion (q) and finds it to be 400 per acre. For a fixed acreage of beach, lower congestion provides higher utility to fewer people; higher congestion provides lower utility but to more people. Median family income in Rhode Island in 1974 was approximately $13,725. The mean value of x is not known, but it is evident that increases in x reduce the willingness-to-pay. The mean value of q is similarly unknown but increases in q reduce willingness-to-pay. There are two obvious assumptions regarding congestion: one is that it is optimal (at 400); another is that it is zero, yielding the highest willingness-to-pay in Eqn. (7). For instance, assuming congestion is optimal, Eqn (7) can be used to calculate the value of a beach-day as a function of temperature for an individual belonging to a family with median income. Carrying out this calculation yields the figures in Table 2. Willingness-to-pay would be higher for zero congestion. The fact that we do not know the level of congestion (q) suggests that these figures are subject to considerable uncertainty.

<u>3. Binkley and Hanemann</u> In 1978 Clark Binkley and Michael Hanemann published an analysis of the value of beach recreation and water quality improvements for beaches in the Boston area.[24] This is among the more carefully designed and executed studies of beach recreation available. The authors collected data on

beach recreators in the Boston area by administering approximately 500 in-person interviews in December, 1974. The survey instrument included a large variety of questions on beach use. The authors were interested in estimating a model of site demand that explicitly considered choice among alternative beaches. Thus they asked questions of the following nature (the questions are paraphrased):

1. How many times during the past summer did anyone in your household visit specific beaches in the Boston area?

2. How long did it take for you to get to each beach and how much did it cost for you to travel there and back?

3. Why do you visit __(site name)__ most often?

4. If this site became much more polluted, what would your response be?

5. How much would the cost of this site have to be raised before you would start visiting your second most favorite site more? (WTP1)

6. Suppose your favorite beach were to become very polluted. This could be avoided if sufficient funds were collected. How much would you pay to prevent this deterioration in water quality? (WTP2)

7. Suppose with appropriate funds, the water quality of your favorite site could be dramatically improved. What is the most you would be willing to pay for this? (WTP3).

Although the authors collected travel cost information, including time, they did not calculate travel cost or carry out a travel cost analysis of the value of a beach-day.

An interesting feature of this study is its emphasis on substitute sites. The authors asked a series of questions with the obvious intent of learning why one site is chosen over another. For instance, question 3 seeks to determine why the respondent chose the most commonly visited beach. The most frequent response to this question is proximity (47.5% of respondents). The second most frequently cited reason (12.3% of responses) is that the respondent's friends go there. A lack of crowding was the most important factor for only 3.6% of respondents. The importance of proximity suggests that the effort involved in traveling is a major determinant in deciding which beach to visit. Furthermore, in response to question 4 above, 56.9% of the respondents said they would switch to another site should their favorite site become very polluted. This suggests the important role of other beaches as substitutes when one's preferred site becomes unavailable or unattractive.

In what was basically a CV study, the authors used several different questions to elicit willingness-to-pay. They first asked the willingness-to-pay to move to the respondent’s second favorite site (WTP1). This should provide an estimate of the incremental value of the favorite beach. The authors also asked two other questions related to water pollution: how much the respondent would be willing to pay to avoid increased pollution (WTP2), or to improve water quality from the current state (WTP3).

Binkley and Hanemann report mean and median responses to all three of these willingness-to-pay questions. Interestingly, mean responses to the three willingness to pay questions are in a very narrow range ($1.98-$2.08). Median responses are lower but fairly similar ($1.08-$1.24). The authors also attempted, unsuccessfully, to estimate an ambitious multiple site demand model, taking into account characteristics of multiple sites.

4. Moncur One of the few true travel cost analyses of beach recreation was done by James Moncur (1975) for beaches on Oahu, Hawaii. He focused on recreation on the island by local residents. According to him, all residents were within 40 miles of all of the beaches.

His approach was to conduct a mail survey (in 1972) of a sample of the Oahu population. Although his sample size was large (several thousand), his response rate was modest (31%). Using ZIP code to identify each respondent's location he calculated the travel distance and travel cost to each beach for each respondent. Unfortunately, he does not provide much information on exactly how travel costs were computed.

Moncur estimated a model that specified the per person visitation rate as a function of the travel cost to each of eleven beach areas. He then calculated a population demand function for each beach and measured the surplus associated with each beach, holding the price of other beaches constant. Moncur was then able to calculate the surplus per person-beach-day for nine of the beaches examined. Those figures are on the order of $1 per beach day (1972 dollars) and are given in Table II. Significantly, this is one of the few studies that looked at the cost of visiting substitute beaches when calculating the value of a specific beach.

5. NOAA Public Area Recreation Visitors Survey (PARVS) Since 1987, the National Oceanic and Atmospheric Administration (NOAA) has been conducting surveys of coastal recreation sites in the U.S. According to Leeworthy, Schruefer and Wiley (1991), over 15,000 interviews have been conducted at various recreation sites. These surveys involved intercepting visitors at particular beaches, administering a questionnaire in-person and giving the respondents a written survey to complete later and mail back.   Data collected

include responses to CV questions on the value of beach recreation and information that would permit an analysis of travel expenditures.

The CV portion of the survey included the following question:

> Suppose the agency that manages this site started charging a daily admission fee of [random number] dollars per person. The money from the admission fee will be used to maintain the site in its present condition, but there would be no improvements. Would you continue to use this site?[25]

Responses indicate that the median value visitors assign to using these beaches is typically under $6. Similar values were reported for approximately two dozen other beaches around the country. With the exception of one beach in Oregon, for which the median value of a beach day was $13, all beaches generated median values less than $7 per day.

Leeworthy and Wiley also used the NOAA surveys to relate the number of trips to a particular beach to a variety of factors, including travel cost.[26] The beaches considered are three Southern California beaches, one New Jersey beach and two Florida beaches. These analyses suffer from several shortcomings, however.

One flaw is evident in the treatment of travel cost, which is set at $0.13 per mile traveled, for all visitors. The authors effectively aggregated together trips of very different types. A three week trip to Florida from England was treated as the same commodity as an afternoon's excursion to a Florida beach by a local resident. Furthermore, and perhaps more important, the trips per year variable, which is used as a regressor, will likely be biased upwards due to the nature of the question pertaining to visitation rates. Respondents who have traveled a long distance to the beach, e.g., from England to Florida, may only make one trip every several years, or even one in a lifetime. Failing to recognize this introduces an important source of error into the data used for estimation.[27]

It should also be pointed out that the NOAA analyses cannot be used to determine the value of a specific beach because costs of using substitute sites are not included in the estimating equations. To see the importance of this, consider the estimated demand function for beach visits at Clearwater Beach in Florida. This equation indicates that if an admission price of $400 per person were imposed there, with no fees at other beaches, people would continue to visit, though cutting back to a mean rate of one visit per year from a mean of 6.8. This is simply implausible. Rational consumers would find substitute sites for beach recreation under these circumstances.

The NOAA data sets represent a large, potentially useful set of data for future empirical work on the value of recreation. To date, however, the analysis carried out with these data has suffered from important shortcomings.

<u>6. Bockstael, McConnell and Strand</u> Nancy Bockstael, Kenneth McConnell and Ivar Strand undertook a major analysis of the benefits of water quality improvements in the Chesapeake Bay (Bockstael et al, 1988). Although the authors examined a variety of types of recreation, of interest to us is their analysis of beach use on the Maryland western shore of the Bay.

Research Triangle Institute, working with the authors, surveyed a large number of visitors to twelve beaches during the summer of 1984. They then undertook two travel cost analyses of beach use. The authors used two models to estimate beach demand: a varying parameters model and a discrete choice nested multinomial logit model. As the authors state, neither was perfect for the application. The varying parameters model assumed each visitor used each of the twelve beaches during the season. The discrete choice model has a number of well-known problems, including the difficulty in representing demand for multiple trips to the same site.

For the varying parameters approach, the authors specified a model in which the number of trips to a specific beach for a specific household depends on a) out-of-pocket travel expenses (mileage and admission fees), b) trip time, c) trip expenses and time for a single substitute beach, and d) ownership of a boat, RV or pool. Thus, the authors explicitly take into account substitute recreation opportunities. It appears that the specification used yields estimates of a household demand function rather than a single user's demand.

The demand function the authors specified is linear, and consumer's surplus per trip can be calculated for the mean number of trips from the results they report.[28] Performing this calculation yields a household consumer surplus of $4.70 to $38.50 (1984 dollars) for the six beaches with significant own price coefficients. The authors do not report average household size. Assuming an average household size of 3.78,[29] the per person value of a beach visit ranges from $1.24 to $10.19, and values for five of the six beaches are between $1.24 and $3.04. The average value over the six beaches is $3.23. Note that results for one beach are much higher than for the other five. This beach also had the highest cost of substituting to another beach, with travel time of over one hour. This isolation, i.e., lack of cheap substitutes, could explain the high estimated value.

7. McConnell (New Bedford) Kenneth E. McConnell participated in a telephone survey of beach use in New Bedford, Massachusetts (McConnell, 1992). The issue of interest was damages from PCB contamination of the area's beaches, so the sites studied may be less desirable than a typical beach. The survey was conducted in March 1986 of 545 New Bedford area households. Respondents were

asked about their residence location and the annual number of visits they take to each of two beaches in the area. They were also asked how frequently they would visit if the PCBs were cleaned up. Thus, the contingent valuation question pertains to how many visits they would make if the pollution were eliminated. The author estimated a travel cost model for each beach, and included the travel cost to substitute beaches as a factor affecting use. From this, consumer surplus per beach visit per person can be calculated, both with PCBs and without. The resulting values for a beach day are very low; using the median number of visits (instead of the mean), yields values per beach day without PCBs of $0.58 to $0.94 (1986 dollars).

C. Summary of Studies

What can be learned from this review? Our first conclusion is that none of the studies is perfect. Most of the CV studies were relatively primitive by today's standards; few reflect the recommendations of the NOAA panel. The CV questions were often open-ended and were rarely posed as realistic decisions trading off some expenditure with the provision of a good. Of the CV studies, three seemed to be the best, though not without problems: Binkley and Hanemann, McConnell (Rhode Island), and the NOAA studies.

The travel cost studies also vary in quality. Typically, travel costs are imprecisely or incorrectly computed, demand equations are improperly specified or substitutes are omitted. The NOAA travel cost studies had so many problems that we excluded them from our tabulation of beach value estimates. The Bell and Leeworthy study also had sufficiently serious flaws that we would advise excluding their results from the set of defensible values of a beach day. Of the travel cost studies, two appeared to be the best, though again not without problems: Moncur and Bockstael et al.

Turning to Table 2, the CV studies are remarkably consistent in the values they report for a beach day. Despite variability in the type of CV question posed, all studies yield values of a beach-day from under a dollar to almost six dollars, with the preponderance of values between one and four dollars per day. The two studies that provide for seasonal or temperature variation indicate that values do vary substantially by season.

The travel cost/travel expenditure studies have a wider range of values than the CV studies, in part because of the range of choice researchers have in analyzing the data, e.g., in functional form for demand and in computing travel cost. Of the two travel cost studies that seemed most carefully done, one (Moncur) generates values consistent with the CV studies, \$1-\$4 per day. The other (Bockstael et al) finds that values for five of the six beaches considered have values of \$1-\$4 per day as well, consistent with the CV numbers. One of their beaches yielded a value of \$12.47, but this probably results from its isolation and lack of inexpensive substitutes. All of the other travel cost studies, excluding the problematic ones mentioned above, obtained values of \$1-\$3 per day.

Overall, the bulk of the existing literature places the value of a saltwater beach day, independent of season, in the range of \$1-\$4. Some studies place the value as high as \$12, but these appear to suffer from significant flaws. Also, these values apply to day-use, not overnight tourist use.

V CONCLUSIONS

This paper reviewed some of the problems and methods associated with estimating the damage from lost beach recreation due to an environmental accident. We focused on estimating lost attendance and on transferring the value of a lost beach day from other studies. Clearly, the option of conducting one's own study of the value of beach recreation for the beach affected by the environmental accident should also be considered.

One of the more important conclusions reached is that lifeguard counts of beach visits may well be inaccurate, with over-reporting by as much as a factor of almost five on a busy day. Aerial photos, combined with on the ground surveys of trip duration, can be used to provide defensible estimates of visitation.

The literature on valuing saltwater beach recreation places the value of a beach day in the $1-$4 range (1990 dollars). There is considerable room for improvement in our understanding of these values, however. Most of the CV studies of beach recreation are now fairly old, and generally did not use methods that are up to the present state-of-the-art. Some of the travel cost studies have shown the importance of including visit-specific or site-specific attributes, such as crowding, temperature, and season. Most travel cost and CV studies have ignored such considerations, however, in their design. The travel cost literature on beach recreation is often very casual about how travel cost is actually computed, sometimes to the point of ignoring time costs. Both travel cost and CV studies often fail to incorporate opportunities to visit substitute sites in the study design.

Finally, none of the studies completed to date sheds light on the potential for substituting visits over time; i.e., on the loss the recreationist experiences when a trip is delayed, but not eliminated entirely. This is, arguably, a very important gap in our knowledge with regard to assessing the damages from temporary beach closures.

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Table 1: Reported Attendance vs. Attendance Estimated from Aerial Photographs

Beach	Date	Mean visit duration	Maximum number of visitors	Reported visits	Estimated visits	Estimated /reported visits
Huntington City	17 Feb 95 (Fri.)	1.91	700	6,242	2,676	0.43
Huntington City	18 Feb 95 (Sat.)	2.73	3938	22,132	9,631	0.44
Newport	17 Feb 95 (Fri.)	1.75	1091	14,000	4,225	0.30
Newport	18 Feb 95 (Sat.)	2.59	5911	75,000	15,529	0.21

Notes:

1. Maximum quantity of people on the beach at any one time is assumed to be the number of people counted on the 1:30 p.m. aerial photo. Mean visit duration is in hours.

2. Estimated attendance is computed using aerial photographs and surveys of visit duration, as described in the text.

3. Sample size for computing duration: Huntington City, 74 (Feb 17) and 131 (Feb 18); Newport Beach, 107 (Feb 17) and 117 (Feb 18).

4. The weekend of Feb. 18 was a holiday (President's Day) and the weather was warm and sunny.

Table 2: Summary of Identified Saltwater Beach Valuation Studies

Description [Including state and date of data]	Original Value ($ per beach-day)	Value in 1990 $
CONTINGENT VALUATION ESTIMATES:		
Bell and Leeworthy (1986) CV Approach [3/1984, Florida]		
Mean	$1.31	$1.63
Median	$0.33	$0.41
Marginal	$0.77	$0.96
Binkley and Hanemann (1978) [12/1974, Mass.]		
WTP1 (Mean, Median)	$1.98, $1.08	$4.88, $2.66
WTP2 (Mean, Median)	$2.08, $1.24	$5.13, $3.06
WTP3 (Mean, Median)	$2.03, $1.24	$5.01, $3.06
McConnell (1977) [8/1974, Rhode Island]		
at 60^{o} F	$0.37	$0.95
at 70^{o} F	$0.78	$2.00
at 80^{o} F	$1.68	$4.30
NOAA (Leeworthy et al, 1989-94)--median [1988-90, Northeast, Florida, Pacific Coast]		
Cabrillo-Long Beach/Santa Monica	$1.12-1.89	$1.16-1.95
Other Southern California beaches	$1.00-5.22	$1.03-5.39
Florida	$1.85-2.38	$1.91-2.46
All U.S.	$2.09-4.31	$2.16-4.45
TRAVEL COST ESTIMATES:		
Bell and Leeworthy (1986) Travel Expenditures [9/1983, Fla.]		
Average	$10.23	$13.00
Marginal	$1.08	$1.37
Moncur (1975) [8/1972, Hawaii]	$0.35-$1.37	$1.07-$4.18
Bockstael, McConnell and Strand (1988) [1984, Mass.]		
Range, six beaches	$1.24-10.19	$1.53-12.55
Mean, six beaches	$3.23	$3.98
McConnell (1992) [11/1984, Massachusetts]	$0.58-0.94	$0.70-1.14

Note: Certain studies identified were excluded from our review and from this table due to limitations with the data or methodology used. These are: Dornbusch & Co. (1982), U.S. Army Corps of Engineers (1981, 1993), Curtis and Shows (1982), and Silberman and Klock (1985).

ENDNOTES

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[*] Department of Economics, University of California, Santa Barbara 93106. The authors were experts for one of several defendants in the *American Trader* oil spill litigation. However, as far as we are aware, all litigation in this case is complete and the case has been settled. Our own involvement ended in 1996. Nevertheless, we should point out that the opinions expressed here are our own. Comments from three anonymous referees and the issue editor, John Braden, are acknowledged and appreciated.

[1] See Chapman et al (1998) and Dunford (1999).

[2] See, for instance, Braden and Kolstad (1991), Freeman (1993) or Kolstad (2000).

[3] Using beaches outside of the accident area is not totally satisfactory since their attendance may be increased by beach closure at the study site.

[4] Dunford (1999) discusses this issue in the context of the Ruud's model.

[5] For instance, one can sample the population on the beach, asking such questions as "How did you arrive at the beach today?" with choices, car, walk, bicycle, city bus, other bus, other. For those who report arriving by car, one can ask whether they parked in an "official" parking lot or elsewhere, and how many persons were in the vehicle.

[6] Chapman et al (1998) report an alternate method which they applied to several beaches in Southern California, including Newport Beach and Huntington City Beach. They stationed monitors at a number of locations along the beach counting the number of people arriving. This would seem to be more accurate than lifeguard estimates though it is not clear how one deals with someone who doesn't stay on the beach during their entire trip but rather goes to the beach, takes a break to obtain lunch, returns, takes another break for a drink, etc.

[7] It may be unclear exactly what is included in reported attendance and what specific uses were precluded by the accident. In particular, which facilities (pier, water, sand, bikepath, parking area, playgrounds) were unavailable due to the accident and which are included in reported attendance? Conservative assumptions are one way of dealing with such ambiguity.

[8] One could distinguish between a twenty minute visit and a five hour visit in terms of value but that is not usually possible.

[9] This adjustment is discussed in Cox (1968).

[10] Note that the probability that i is sampled depends on the amount of time i actually spends on the beach and on the sampling rate during i's visit to the beach area. If i spent four hours in the beach area, with two hours in shops and restaurants, the probability of being sampled would depend only on time actually spent on the beach.

[11] If the visitor spends one hour of a four hour visit off the beach at a restaurant, then this probability must be adjusted by the fraction of time the visitor is on the beach: (4-1)/4 = 0.75. Basically, the longer the visitor is in the beach area, the greater the likelihood of being sampled; the more time spent in a restaurant, the smaller the likelihood of being sampled.

[12] Aerial photos were taken on three other days, though surveying was not done on those days. Using duration data reported in Table I, the discrepancy between actual and reported attendance shown in Figure 1 is evident in the three additional aerial photo days as well. The survey instrument used to generate the duration data may be found in Appendix A.

[13] More detailed discussion of empirical methods for valuing environmental goods may be found in Braden and Kolstad (1991), Freeman (1993) or Kolstad (2000).

[14] The dollar value individuals assign to time spent traveling in vehicles has been studied intensively. Economic evaluation of new rapid transit systems has motivated much of this work, as reduction in travel time is the main benefit of such systems. This extensive literature has been reviewed by others and broad generalizations on the value of time spent traveling have emerged. Heilbrun (1993) concludes that "individuals value travel time at not more than half their wage rate." Sullivan (1991) generalizes from empirical studies of urban transit that "commuters value time spent in the transit vehicle at about one third to one half the wage."
[15] Smith and Palmquist (1994) is one of the few papers we know of that deals with temporal substitution.
[16] For example, McConnell (1977) looks at the effect of crowding and temperature on the value of a Rhode Island beach visit. Binkley and Hanemann (1978) look at the effect of water quality improvements on the value of beach recreation in Boston.
[17] The survey presented here is current, to the best of our knowledge, through mid-1996.
[18]We are excluding a study done by Mead and Sorenson (1970). Their approach to measuring the value of a beach-day of recreation is considerably more problematic than all of the CV studies reviewed here.
[19]See "Natural Resource Damage Assessments Under the Oil Pollution Act of 1990," Federal Register, 58 (10): 4601-14 (January 15, 1993).
[20] See 61 Fed Reg 440 (January 5, 1996) codified at 15 CFR. See also Jones (2000).
section 990.
[21]For example, see Shogren, et al (1994).
[22] McConnell (1977).
[23]It is unclear if visits to the beach are visits to all beaches or visits to the beach where the interview took place.
[24] Binkley and Hanemann (1978).
[25]Question 7, part E, PARVS survey form dated June 1990.
[26]Leeworthy and Wiley (1991, 1993, 1994).
[27]To see the problem, suppose there are 10 such persons and each normally makes a visit every 10 years. If they were interviewed over a 10 year period, each of the 10 would report a visitation rate of 0.1 per year. It appears that the NOAA study would record one visit per year for one person in this instance. This is not equivalent to measuring the visitation rate correctly, and it will not yield accurate data on the relationship between travel cost and visitation rates.
[28]The household's consumer surplus per trip is given by their equation (4.11) divided by the number of trips. The expected household consumer surplus per trip is approximately equal to the average number of trips divided by twice the absolute value of the coefficient on price (access cost) in the demand equation.
[29]The NOAA survey for Pt. Lookout Beach in Maryland shows an average group size of 3.78 (Leeworthy et al,1989). Pt. Lookout is one of the beaches in the Bockstael et al study.