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Collecting and Using Economic Information to Guide the Management of Coastal Recreational Resources in California

A dissertation submitted in partial satisfaction of the

Requirements for the degree Doctor of Environmental Science and Engineering

by

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DEDICATION

I dedicate this dissertation to my wife, Ellen Lougee and sons, Sam and Keeler Nelsen.

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ABSTRACT OF DISSERTATION

Collecting and Using Economic Information to Guide the Management of Coastal Recreational Resources in California

by

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Coastal tourism and recreation is the largest sector of California's ocean and coastal economy and generates large economic impacts that can be measured in the market economy. Coastal recreation also creates large non-market values. Most of the research on non-market values of coastal recreation in California has focused on beach going. There are other niche recreational activities such as surfing, diving, and paddle boarding that have small populations of highly avid coastal users that are difficult to survey. These groups make choices regarding their recreation based on different beach attributes and have distinct behavior patterns and different economic impacts and values associated with their recreational choices. The inability to survey these users limits our understanding of how coastal management decisions affect them and may in result decisions

that negatively impact public welfare. The lack of knowledge about these users has also led to coast management agencies (e.g., California Coastal Commission) to consistently undervalue the impact of decisions on coastal recreation both when making project-specific decisions and when setting mitigation fees. Internet-based survey instruments provide a new and effective way to capture these users. However, Internet-based surveys have advantages and disadvantages that are different than more traditional survey modes.

This dissertation a) uses Internet-based surveys to provide one of the only empirical valuations of surfing, b) develops, tests, and applies an Internet-based survey approach to quantify the values of this niche coastal use, and c) examines the recent history of beach mitigation policy in California to show how coastal recreational and ecosystem values could be better incorporated into the determination of mitigation fees. First, I use an opt-in Internet-based survey to estimate the non-market value of surfing at the Trestles surfing area. I find an average consumer surplus of surfing at Trestles to be $138 per person per visit, which is an order of magnitude higher than values used for past decision making. Second, I compare the use of an opt-in Internet-based survey instrument with an on-site intercept survey to measure the demographics, recreational behavior and consumer surplus of surfers at Trestles. Survey mode is shown to affect the demographic and visitation attributes but consumer surplus values for surfing are similar, regardless of the method used.

Third, I examine the use of non-market values by the California Coastal Commission to mitigate the adverse impacts to beach ecosystem services from the permitting of shoreline protection devices. Shoreline armoring on eroding beaches causes the beach to narrow over time, resulting in the loss of beach ecosystem services, including non-market recreation values. Even when empirically derived consumer surplus values are available, decision makers often do not consistently or rigorously incorporate economic values into project analysis or to establish mitigation fees. I develop a conceptual model to consider the total economic value of beach ecosystem services and compare five case studies to show that the Coastal Commission has used inconsistent methods to estimate the non-market values of lost beach ecosystem services. I recommend improvements on existing methods to more accurately and consistently estimate lost recreational values. A framework is provided to ensure that all sandy beach ecosystem services are considered and make explicit those values that are not being considered.

Chapter 1

Non-market values of coastal recreation in California

Introduction

California has the largest ocean economy in the United States, and tourism and coastal recreation is the largest sector of California's ocean economy (See Figure 1.1) (Kildow and Colgan 2005). It is estimated that there are 150 million beach visits per year in California that generate economic impacts that could exceed $14 billion (King 1999) and net economic benefits that could substantially exceed $2 billion (Pendleton and Kildow 2006). Despite the importance of coastal recreation, relatively little is known about how people use the coast or how coastal management decisions impact coastal recreation. Over the last decade there has been an increased effort to better understand the behavior and economics of coastal recreation (Pendleton and Kildow 2006).

As reported in California's Ocean Economy (Kildow and Colgan 2005), the dominant sector of the ocean economy in California is the combination of tourism and recreation. Tourism often represents visitors from out of state, whereas recreation is most often day use. Tourism and recreation are obviously linked, but calculating the economic value for tourism and recreation require very different economic techniques. Tourism has a market value that is usually measured as gross revenues associated with coastal tourism-based expenditures. The gross revenues, and the jobs and taxes they support, are described in economic literature as economic impacts. The full economic value of coastal and ocean recreation, however, is not fully captured in the market because these activities are typically accessed without charge (with the exception of parking) (Kildow and Colgan 2005). These "non-market" values are the net value added to society that are generated by coastal and ocean recreation. From the perspective of the coastal user, the economic value associated with the use of a public resource is often referred to as consumer surplus.

Non-market values are not captured by standard economic measurements of impact and as a result, information on the non-market value of coastal recreation is often not available to policy makers. Failure to capture non-market values in the decision making process implicitly gives them a value of zero (NRC 2004). Omitting non-market values can lead to management decisions that are biased toward market-based values and without consideration of impacts to coastal uses that are highly valued, although poorly measured, by society. These decisions are often detrimental to the coastal environment and coastal recreation.

There are a number of examples from California for which the inclusion of non-market values in the coastal decision making process could have affected the outcome of local coastal development. In 1966, a harbor was constructed in Dana Point as an economic development project that destroyed a rich nearshore reef ecosystem and a popular surfing area known as Killer Dana. There is no information to suggest that the values associated with the lost recreational fishing, diving or surfing were explicitly considered when this decision was made. The market values associated with development of the harbor were understood but the non-market value of the negative impact to the coastal environment and recreation were likely given a zero value.

Presently in California, seawall construction is permitted to protect the market value of private homes, even in cases where the seawall will narrow or eliminate the public beach. In most circumstances, the non-market values associated with reduced beach recreation are not explicitly considered or mitigated. Fully informed coastal management decision-making that balances development with environmental and recreational protection must include non-market values.

Economic valuation provides an important tool to estimate economic values associated with coastal recreation so that explicit economic tradeoffs can be considered when coastal development impacts recreation or so that mitigation for impacts can be assigned (Turner, Pearce et al. 1993). The estimation of non-market values of coastal recreation provides decision makers with a common metric (economic values) to compare alternatives. Without non-market valuation estimates for coastal recreation, decision makers are left comparing the well understood market value of coastal development with a vague moral value associated with coastal recreation. Without understanding how coastal development impacts the economic values associated with coastal recreation, decision makers risk upsetting the balance between environmental protection, coastal recreation and tourism, and economic development. Effective decision-making requires sound estimates of the economics of coastal uses, data about recreational uses to describe who coastal users are, where and how they use the coast, and how their use generates economic impacts and economic values.

Background and significance

Regulatory protection of coastal and ocean recreation in California

The primary law that regulates coastal zone management decisions along the California coast is the California Coastal Act (CCA). Passed in 1976, two of the primary goals of the CCA are to "Assure orderly, balanced utilization and conservation of coastal zone resources taking into account the social and economic needs of the people of the state" and to "Maximize public access to and along the coast and maximize public recreational opportunities in the coastal zone consistent with sound resources conservation principles and constitutionally protected rights of private property owners (CCA, §30001.5)." Further, the CCA prioritized the protection of water-oriented activities, "Coastal areas suited for water-oriented recreational activities that cannot readily be provided at inland water areas shall be protected for such uses (CCA, §30220)."

The California Coastal Act charges the California Coastal Commission with the decision-making authority to uphold the regulations created to meet these goals. The CCA requires a permit for all development in the coastal zone throughout the state. Coastal development projects must meet requirements in the CCA designed to limit impacts to the coastal environment and recreational activities in this environment.

The CCA anticipated cases where coastal development may cause unavoidable impacts to the coastal environment or coastal recreation. The CCA defined a mechanism for resolution of policy conflicts. "The Legislature further finds and recognizes that conflicts may occur between one or more policies of the division. The Legislature therefore declares that in carrying out the provisions of this division such conflicts be resolved in a manner which on balance is the most protective of significant coastal resources (CCA, §30007.5)." To determine the most protective balance the Coastal Commissioners require information about coastal resources, including coastal recreation. Economic valuation studies provide a tool to compare how a resolution of conflicting policies will affect coastal recreation.

In some, but not all cases, the CCA requires mitigation of impacts. A clear example is when construction alters natural shoreline processes. The CCA states, "Revetments, breakwaters, groins, harbor channels, seawalls, cliff retaining walls, and other such construction that alters natural shoreline processes shall be permitted when required to serve coastal-dependent uses or to protect existing structures or public beaches in danger from erosion, and when designed to eliminate or <u>mitigate adverse impacts</u> on local shoreline sand supply (emphasis added) (CCA, §30325)." The California Coastal Commission can also require mitigation for other types of projects. The California Coastal Act does not contain a definition of mitigation. The Coastal Commission uses the California Environmental Quality Act (CEQA) definition of mitigation (CCC 1997). The Coastal Commission has applied mitigation measures in an *ad hoc* fashion for loss of recreational resources and other beach ecosystem services. There are two ways that the Coastal Commission has required mitigation for the impacts of shoreline protective devices. In some cases, a fee has been assessed to compensate for beach sand impounded behind a seawall that otherwise would have eroded to form the beach. This fee is calculated using engineering and geological information on bluff erosion and sand content (CCC 1997). In at least four cases, the Coastal Commission has required a mitigation fee for the loss of beach recreation. In these cases, the Coastal Commission has attempted to estimate the non-market value associated with lost recreation during the lifetime of the structure and assessed an in-lieu mitigation fee upon permitting the structure.

Environmental valuation

Environmental valuation is a collection of statistical methods based on economic theory that economists use to measure human preferences and assess the economic value of market and non-market goods associated with natural resources and ecosystem services. Economic value is a measure of the maximum amount an individual is willing to forego to obtain some good, service, or state of the world (Haab and McConnell 2002). In a market economy, currency (dollars in the United States) is the typical measure of the amount someone is willing to give up to obtain a good, service of state of the world. This is commonly called the willingness-to-pay. Welfare economics presumes that when the price of a good increases, an individual will consume less (See Figure 1.2). Comparison of price to willingness-to-pay creates a demand curve for the good. Consumer surplus is a measure of the economic benefit to the individual – the difference between the maximum willingness to pay revealed by the demand curve and the price actually paid for the good. Producers of goods also benefit in the form of profit, known as producer surplus. Producer surplus is the return to the producer over and above the cost of supplying a good. A supply curve defines the price at which the producer will supply a certain quantity of goods. The intersection of the demand curve with the supply curve will define the maximum combined consumer and producer surplus (See Figure 1.2).

When goods and services are traded in a market, such as coastal tourism, the market will define their values. Conceptually, the same measure of benefits applies to non-market goods. Since non-market goods, such as a beach, are typically not produced, measures of non-market benefits are concerned only with estimates of consumer demand and consumer surplus (See Figure 1.2) (Lipton, Wellman et al. 1995)

Economic values of coastal recreation

Coastal recreation generates two important economic contributions to the coastal economy; economic impacts and non-market consumer and producer surplus. Economic impact describes the flow of money through an economy and the associated jobs, wages, salaries and taxes associated with these flows. Included in economic impacts are the expenditures by visitors to the coast, who spend money locally on food, beverages, parking, and coastal recreational activities. These expenditures represent expenditure that may have been made elsewhere in the state (e.g., gas and auto), but are mostly expenditures that would not have been made in the absence of a recreational trip (Pendleton and Kildow 2005). Economic value, in contrast, is the net value added to society that the resource provides. From the perspective of the coastal user, economic value often is the non-market consumer surplus associated with the use of a resource. Profit is the non-market value from the perspective of a coastal business. Together these measures (consumer surplus and profit) are the total non-market use value.

Total economic value

The total economic value (TEV) model provides a framework for valuing ecosystem services. The TEV framework is based on the presumption that individuals have multiple values for ecosystems and provide a framework to ensure that components of that value are not missed or double counted (NRC 2004). The TEV framework separates ecosystem services into direct and indirect use values and considers non-use values (Figure 1.3). Use value refers to those values associated with current or future (potential) use of an environmental resource by an individual. The use can either be consumptive (e.g. recreational fishing) or non-consumptive (e.g. surfing or beach going). Direct use values can be measured using revealed and stated preference approaches. Indirect uses are more challenging to measure and often require models that link direct-use commodities with services (NRC 2004). Production function approaches seek to determine how changes in ecosystem services affect an economic activity, then measure the impact of the change on economic activity (NRC 2004). An example of this is linking loss of sandy beach prey resources to lower biodiversity of shore birds, and then to the change in consumer surplus to bird watchers.

Option and bequest values describe the value of preserving the option for use of services in the future either by an individual (option value) or by future generations (bequest values). The primary non-use value is existence value. Existence value is unrelated to the use of the resource and represents the willingness to pay for the resource to exist (e.g., willingness to pay for the protection of a beach you will never visit). Non-use valuation requires contingent valuation methods (NRC 2004).

Ecosystem services

Efforts to define and value ecosystem services go back several decades (Loomis, Paula et al. 2000). Ecosystem services are the benefits people obtain from ecosystems. The full definition of ecosystem services provided by the Millennium Ecosystem Assessment (MA) project (2005) is:

> Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other nonmaterial benefits (MA 2005).

The ecosystem services model is anthropocentric by definition, but the MA makes clear that sound ecosystem management must include the intrinsic values of ecosystems. Intrinsic values cannot be given a monetary value and instead require a values-based decision making structure (MA 2005). Ecosystem services can be valued using both supply and demand-based methods. Supply based methods include service-for-service methods, such as those used in Habitat Equivalency Analysis. These values are derived from replacement cost of the resource. Demand based methods are based on the TEV model and require estimating non-market values, typically expressed as consumer surplus (Hampton and Zafonte 2002).

Valuation methods

Estimating market values generated by coastal recreation and tourism is limited only by capturing information about business finances or spending by coastal users. Once this information is collected, calculating their expenditures requires only accounting. Unlike marketed goods and services, recreational activities often occur without the explicit exchange of money so they require different methods of measurement. There are a variety of methods to capture non-market values associated with coastal recreation. They fall into two primary categories: revealed preference and stated preference methods. Revealed preference methods seek to identify underlying preferences based on choices the user reveals in their patterns of consuming natural resources or in the consumption of marketed resources that are associated with the use of that resource. For example, a user's willingness to spend time and money to drive to a site that provides a particular coastal amenity reveals a minimum value for the use of the resource. Stated preference methods use survey instruments to gauge a users willingness-to-pay based on their response to questions designed to elicit a value for a resource. Stated preference methods are often used to gauge the value of a hypothetical or proposed change in a resource (Haab and McConnell 2002).

Contingent valuation

The contingent valuation method (CVM) is a stated preference method. CVM is designed to recover information about preferences or willingness-to-pay using direct questions. CVM usually takes the form of a survey questionnaire. CVM can be used to value a hypothetical future condition. For example, Bhat (2003) used CVM to estimate the non-market recreational benefits from snorkeling and diving associated with improved reef health in a proposed marine reserve. In some cases CVM is the only means of estimating willingness-to-pay. CVM is also the only way to measure the value of passive uses. Passive uses entail no direct involvement with the natural resource. Passive use values were used to assess the settlement for damages from the Exxon Valdez oil spill in Alaska and for the DDT released into the ocean off of Palos Verdes, CA (Carson, Hanemann et al. 1994; Carson, Mitchell et al. 2001).

CVM is highly sensitive to the survey instrument and method of asking the questions. CVM has been controversial because it relies on hypothetical situations and personal preferences, but resource economists have accepted CVM as a reliable method for environmental valuation (Haab and McConnell 2002). The National Ocean and Atmospheric Administration (NOAA) has established guidelines for best practices to create consistency across CVM studies (Arrow, Solow et al. 1993). Chapman and Hanemann (2001) argue that current studies using contingent valuation to estimate values for California beach visits are unreliable because the surveys are not site specific and fail to account for variation in travel cost to beaches throughout the state.

Travel cost method

The travel cost method (TCM) is a revealed preference method. TCM is based on the premise that visitors reveal their willingness-to-pay to visit a site through travel time and costs. The TCM was first suggested in the late 1940s by Harold Hotelling as a means of valuing public lands. Since that time TCM has become a popular method for estimating non-market values for recreation, appearing in thousands of academic journal articles (Haab and McConnell 2002).

TCM studies can be divided into single site models and multiple site models. The single site TCM creates a demand function by observing that visitors who live farther away from a desired location will incur higher travel and time costs to make a visit and will visit less frequently (Parsons 2003). Comparison of the number of trips taken across varying travel costs creates a demand function for a specific site. The demand function can be used to determine the benefit derived for each visitor, known as the consumer surplus (See Figure 1.4). Multiplying the average consumer surplus value by the annual number of visits shows the total recreational value derived for a site.

Single site models are best used to assess the total use value of a site that has few substitutes. Single site methods are less powerful when used to measure how environmental change will affect the value of a site or if a site has many alternatives.

A widely used multiple site model is the Random Utility Model (RUM). A RUM models visitors' discrete choices of sites from a set of multiple possible sites. Site choice is dependent of the characteristics of the site. The choice of sites reveals how visitors values different site characteristics by examining how they trade off additional travel cost to gain more or less of an amenity. A RUM can be used to value an entire site or to value changes in environmental quality at one or more sites (Parsons 2001).

Benefit transfer method

The benefit transfer approach, more accurately called a value estimate transfer, seeks to apply existing value estimates and transfer them to a new site. Conducting original valuation research is time consuming and expensive. Benefit transfers are commonly used in cases where there is neither time nor funding to perform a site-specific valuation study. It is generally agreed that benefit transfers are a "second-best" valuation method (NRC 2004). Benefits transfer methods are becoming increasingly common, but there is currently little consensus that benefits transfer methods are accurate or appropriate in many cases (Wilson and Hoehn 2006). Benefits transfer is limited by the quality of the original study and most studies do not provide enough detailed information on site characteristics or recreational uses to accurately adjust values to a new site (Wilson and Hoehn 2006). A conservative approach is to provide information on a the full range of values for a recreational activity based on the literature available and then estimate a range of values based on end points of the range found in the literature (Pendleton 2008).

Coastal recreation studies in California

The National Ocean Economics Program database lists 31 papers and reports on economic valuation of coastal recreation in California dating back to 1993. Research on beach going (including beach-related water quality studies) represents the largest portion of the research with 14 papers and reports (See Figure 1.5). The beach recreation papers can be divided into two groups, those reporting on economic impacts (market expenditures) and those reporting on non-market values, with some reporting on both.

Market values of California beach recreation

King (1999) estimated the fiscal impact of California beaches and found that beach visits generated $14 billion in direct revenue. Other studies have estimated the average expenditures per person per day trip ($/trip/person) for visits to California beaches. In a study of San Clemente beaches, King found that average beach related expenditures (including gas and automobile costs) were $54.79 per individual visit. A survey of beach goers in Southern California (Hanemann, Pendleton et al. 2002) found that per person per trip expenditures on beach related items and services were $23.19 for beach goers that took at least one trip in the summer of 2000. Nelsen, Pendleton, et al. (2007) surveyed surfers visiting Trestles Beach near San Clemente and found an average expenditure per trip to be $40.20 and estimated that visits to Trestles Beach produced an economic impact of between $8 million and $13 million to the City of San Clemente.

Non-market values of California beach recreation

Leeworthy and Wiley (1993) found that recreational use values for three Southern California beaches had annual non-market values of $360 million ($1993) and found average values per person per day trip to range from $12.19 to $77.61. Leeworthy (1995) estimated values of $85.39 and $90.58 ($2005) per person for San Onofre State Beach and San Diego beaches, respectively. Chapman and Hanneman (2001) estimated a consumer surplus value of $13 ($1990/trip/person) at Huntington Beach. Hanemann, Pendleton et al. (2004) conducted a intensive study of coastal recreation at 53 beaches in Orange and Los Angeles counties in California. Using a RUM, they estimated the net change in the economic values across all beach sites due to changes in either water quality or beach closures of different durations or at different sets of beaches. This study didn't estimate per person values for individual beach visits. Lew and Larson (2005) used a random utility model to estimate the value of recreation and specific amenities at 31 San Diego County beaches. They found an average value of $28.27 ($2005) per individual visit. They also found that the certain beach amenities including presence of lifeguards in towers, activity zones that separate swimmers from surfers, and free parking are important (statistically significant) to beach goers. Interestingly, their study found that water quality conditions are not a statistically significant factor in beach choice. Lew and

Larson (2005) did not aggregate their per trip per person value to a total annual value for San Diego County beaches because of the lack of availability and reliability of beach attendance data. Pendleton and Kildow (2006) created an aggregated estimate for the non-market value of all beach recreation in California through a two-step process. Using existing literature, they estimated the total number of annual beach visits and then used a benefits transfer approach to estimate a range for the average per person per trip value. They used a conservative estimate of 150 million annual beach visits and found that the non-market value of California beach visits ranges from $2.25 billion to $7.5 billion per year ($2005).

Economic values to mitigate for lost beach going and surfing

A common use for economic valuation is for natural resource damage assessments (most famously for the Exxon Valdez oil spill). As seen above, the literature provides a sound basis for determine values associated with beach recreation. However, when looking at a subset of beach recreation, such as surfing, it becomes more difficult to estimate appropriate values. For example, the Southern California Beach Valuation project (Hanemann, Pendleton et al. 2004) found that environmental degradation (poor water quality) resulted in substantially different non-market impacts for different types of beach goers. The study, however, did not look explicitly at different types of water activities, because the sample sizes were too small.

In California, there are two published cases that describe the use of economic valuation for the loss of surfing resources. Both cases use non-empirical and inadequate methods to determine the value of lost surfing because there is no literature or studies on non-market values associated with surfing. Oram and Valverde (1994) describe the methodology used by the Surfrider Foundation to argue for mitigation of lost surfing due to the construction of a large groin in El Segundo, California. By comparing a day of surfing to the entrance fee of a water park, the Surfrider Foundation estimated that the lost surf resulted in damages worth $244,000 to local surfers.

> Surfrider's analysis began with the cost of admission to Raging Waters, a commercial wavepool [*sic*] park located in Palm Springs, California. Multiplying the $16.95 admission fee for an adult "surfer" by fifty surfers per day equals $847.50 per day. Based on the history of the affected surf break, Surfrider estimated the break would offer good surfing conditions three days per week, six months out of each year (October to March). Since the break at El Segundo had been affected for approximately four years (1984-1988), Surfrider claimed a total of $244,080 in damages to surfing (Oram and Valverde 1994 p.12).

To assess the value of lost beach recreation from the *American Trader* oil spill in Huntington Beach, California, Chapman and Hanemann (2001) extensively surveyed beach users and used the TCM to value lost beach during the 34 day closure period. The economic valuation techniques were highly scrutinized and challenged throughout the legal case that ultimately awarded $18 million to the State of California for lost recreation. Although beach recreation was based on TCM methodology, surfing was valued based on a non-empirical approach. They estimated a per trip per person value using a similar approach to the El Segundo case (described above).

> While surfing is a specialized recreation activity which would generally be considered to have a higher unit value than general beach recreation - (see, for example, Walsh et al. (1998) - we knew of no valuation study that dealt specifically with surfing. We decided to use a unit value of $16.95 per surfing trip. This corresponded to the entrance fee at an inland water park in Southern California; the amount was suggested to us by an official of the Surfrider Foundation, who thought most surfers experienced a consumers' surplus at least equal to this, and it represented a premium of about 30% over our estimate of the unit value of general beach recreation (Chapman and Hanneman 2001 p.12).

With the addition of new data sources on the value of beach visits, Chapman and Hanemann (2001) refined their estimate value for a surfing day in Orange County.

> We believed that a different value should be used for surfing, since it is a more specialized activity that requires a higher degree of skill, knowledge and appreciation, and draws a very loyal following. Based on the travel cost literature, we believed that the consumers' surplus for surfing in Orange County was likely to be at least 25% higher than the consumers' surplus for general beach recreation, and we therefore used a value of $18.75/trip in 1990 dollars for surfing trips lost (Chapman and Hanneman 2001 p.13).

Lack of user data specific to surfing limited the accuracy of the per trip, per person value.

Chapman and Hanemann (2001) did make an effort to better understand what percentage of beach visits were represented by surfers. To capture surfers, they extended their survey to start at 6 a.m. and continue to 6 p.m. In doing so, they found that the percentage of beach visits that were for surfing ranged from 10-18%.

Statement of the problem and objectives

Coastal recreation in California is under threat. Increased coastal urbanization, declining water quality, sea level rise and shoreline armoring pose threats to California's beaches and surfing areas. A better understanding of the economic values of coastal recreation may even the playing field when decision are made that attempt to balance coastal development with protection of coastal resources, including recreation.

General studies on coastal recreation have been completed but they often fail to capture the diversity of coastal users, what natural and developed features attract them, or what environmental issues influence their choices. Without this kind of information, it is difficult if not impossible to fully understand how coastal zone management decisions will impact recreational use and the economic values associated with these uses.

Beach goers use the coast for a diversity of activities including walking, tidepooling, swimming, surfing, snorkeling and kite boarding. Compared to the large category of general beach goers, some specific activities have relatively small user groups and thus are hard to intercept via population-wide surveys (e.g., phone or mail surveys) or even on-site surveys. These users may make very specific decisions about their beach visits that are different from a basic beach visit and as a result, they way they respond to environmental change and the value they place on beach characteristics may differ from beach goers generally. For example, surfers may be more likely to avoid beaches with chronic water pollution issues. Tidepoolers may look for beaches with marine protected areas. SCUBA divers may desire parking close to the beach to facilitate transporting their heavy gear. Volleyball players will seek wide beaches with numerous volleyball courts.

Because the dominant use of beaches is "beach going," most studies have focused on this large group and assumed that their findings are representative for all coastal recreation. Most studies measure beach going generally and do not identify smaller subsets of people that may have very different behaviors and responses to coastal management decisions. In some cases entire users groups may be missed when assessing mitigation for impacts to coastal recreation. This can occur because the subset of users is too small to be captured in randomized phone surveys, or they use the coast differently than typical beach users (different times, locations and seasons) and are missed by on-site surveys. One possible solution to capture these smaller, hard to reach subsets of coastal users is through targeted Internet-based survey instruments.

Even when consumer surplus values are well studies in the academic literature, such a beach going in California, coastal zone managers are challenged by attempts to apply these values in decision making processes due to limited expertise, funding and permit timelines. As a result, the Coastal Commission has used an inconsistent and incomplete approach to mitigating for adverse impacts to surfing areas and local shoreline sand supply. The Coastal Commission has applied different methodologies for each project to determine the value of lost recreational use and has not consistently accounted for ecosystem service losses. As a result, mitigation fees are often subject to litigation, values for lost recreation are undervalued, and other ecosystem services values are not considered.

This dissertation seeks to assess the effectiveness of using Internet-based surveys to estimate non-market values for hard to survey coastal users in California and to review the use of non-market values of coastal recreation for decision making by the California Coastal Commission. This research will 1) apply an Internet-based survey to surfers to estimate the non-market value of surfing at Trestles Beach 2) evaluate the effectiveness of using an internet-based survey by reviewing the literature on internet-based survey instruments and comparing an Internet-based survey to an on-site intercept survey of surfers. Last, this dissertation will review the recent use of non-market values by the California Coastal Commission to mitigate for adverse effects from the construction of shoreline protective devices.

Objective 1: The Economic Value of Surfing: Use Internet-based surveys to capture difficult to reach recreational users to calculate non-market values of coastal uses.

Small or difficult to monitor groups of beach users that have unique interests, such as surfers, divers and kite boarders, represent a unique challenge to survey research. They are hard to identify in random samples of the population, their use has high spatial and temporal variability, and they may have a low response rate to in-person interviews (Shaw and Jakus 1996; Hanemann, Pendleton et al. 2004). Surfing is an example of this type of coastal recreation. Surfers may represent up to 20% of beach visits at certain beaches, but they are often underrepresented in beach going surveys (Chapman and Hanneman 2001). An Internet-based survey of surfers is used to estimate the non-market value of surfing at Trestles Beach. Surfers are representative of a hard to measure user group because their numbers are too small to capture by randomly sampling the population, they have a low response rate to on-site surveying, and they use the coast at times that are different than other beach goers.

Objective 2: Test the effectiveness of an Internet-based survey to estimate the economic impact and non-market consumer surplus values for surfing at Trestles.

Use of Internet-based survey instruments may facilitate responses from these hard to reach user groups. Internet-based surveys are becoming increasingly popular because of their ease of use and cost savings but they have known issues that limit the ability to generalize responses to a larger population (Couper 2000). Couper (2000) identifies sampling error, coverage error and non-response error as the major limitations to extrapolating results from Internet-based surveys to a larger population. As more households give up wired telephone service and exclusively use cellular phone service, telephone surveying faces similar challenges (Dillman, Smyth et al. 2009).

To improve our understanding of the potential biases for use of Internet-based surveys, we describe the benefits and limitations of Internet-based survey instruments and compare an internet-based survey to an onsite intercept survey.

Objective 3: Mitigating the adverse impacts of shoreline armoring on California beaches

The Coastal Act was written to ensure balanced utilization of coastal zone resources taking into account the social and economics needs of the people of the state and to maximize public access and recreational opportunities (CCA, §30001.5). The act specifies that water oriented activities shall be protected (CCA, §30220) and that in cases where impacts to coastal recreation those should be mitigated (For example CCA, §30325). In some cases the mitigation is through project design and in other cases the mitigation is monetary. To date, mitigation through monetary compensation has been applied in an *ad hoc* fashion and the CCA does not provide a framework or guidance for establishing mitigation values. Attempts to mitigate impacts to coastal recreation through monetary compensation have resulted in litigation. The Coastal Commission would benefit from a consistent approach for assessing mitigation fees. The objective of Chapter 4 is to provide conceptual models for supply and demand based approaches for mitigating for adverse impacts on local shoreline sand supply, discuss their strengths and limitations, review the use of non-market values to estimate lost coastal recreation, show through comparative analysis of past projects (case studies) how the Coastal Commission approaches have either over or underestimated the value of lost beaches, and provide recommendations for a consistent, more accurate approach based on accepted practices in the literature.

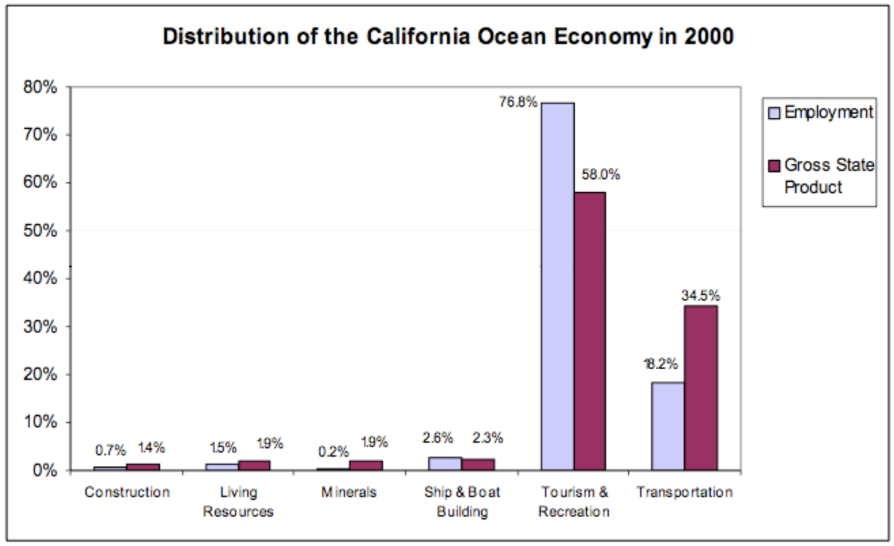

Figure 1.1 Distribution of California ocean economy in 2000 (Kildow and Colgan 2005).

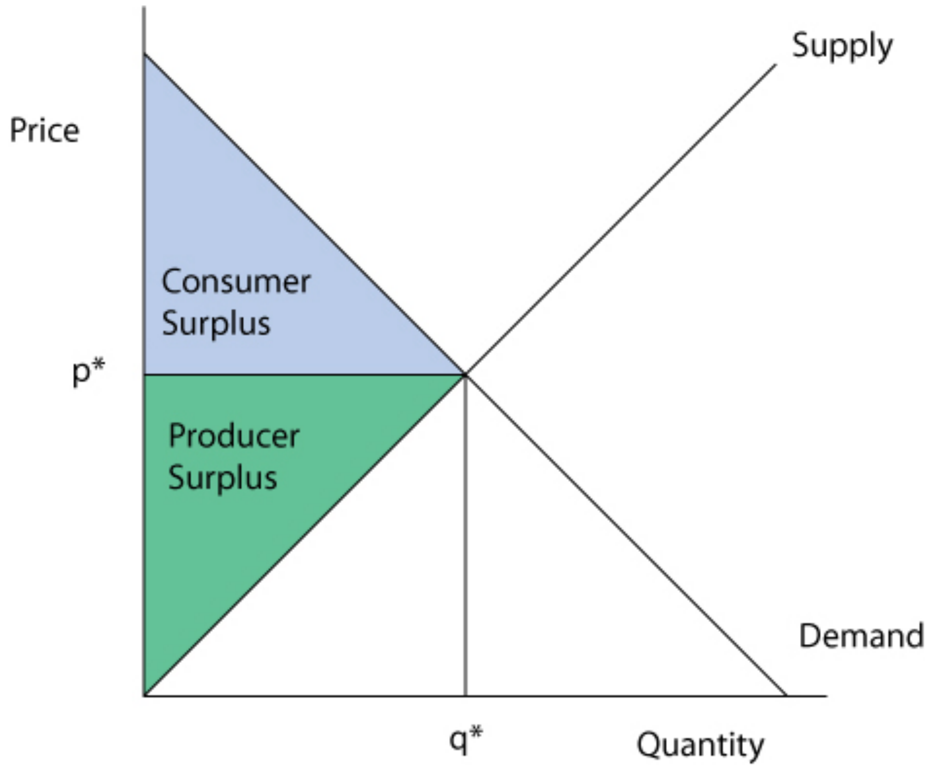

Figure 1.2 Consumer and producer surplus show the equilibrium point at q* and p*.

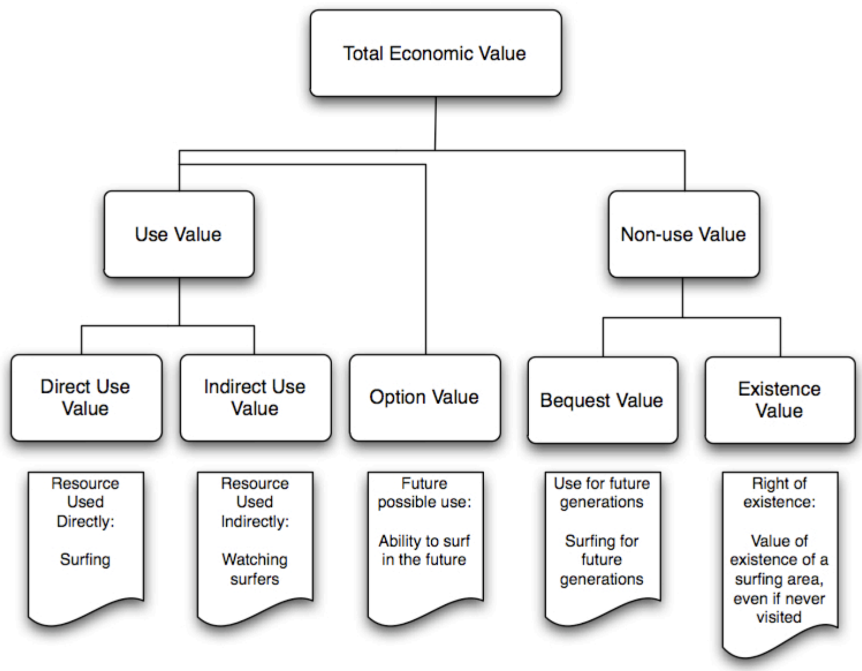

Figure 1.3 The total economic value of ecosystem services with examples for surfing (based on Freeman 1993).

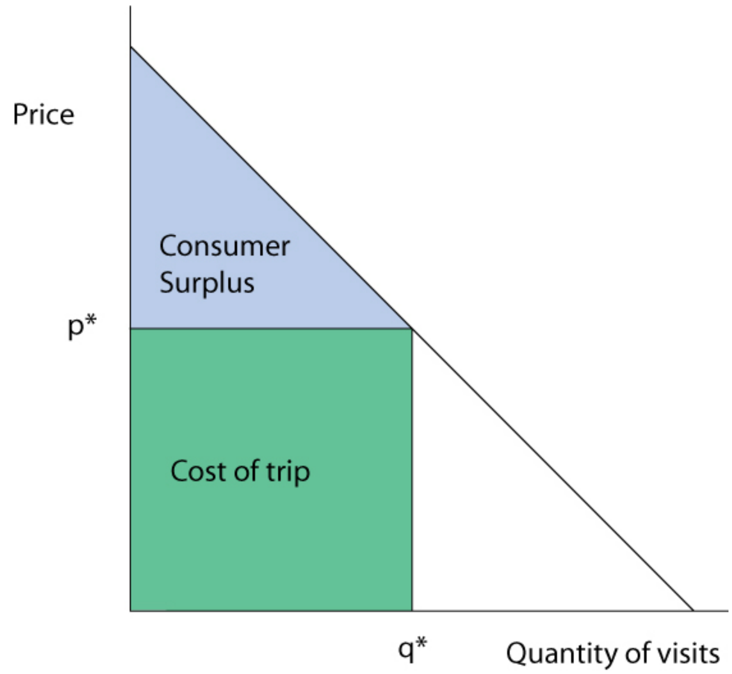

Figure 1.4 Recreational demand curve with consumer surplus.

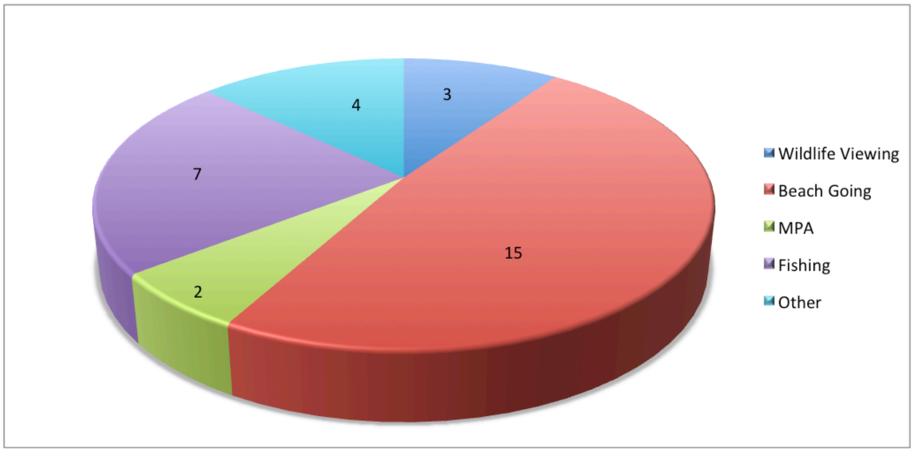

Figure 1.5 Number of economic valuation papers on California coastal recreation from the National Ocean Economics Program database.

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Chapter 2

Using an Internet-based survey instrument capture hard to reach beach users and develop a travel cost model for surfing at Trestles Beach, California

Introduction

Coastal tourism and recreation is the largest component of California's coastal economy (Kildow and Colgan 2005). Over the last decade there has been an increased effort to better understand the behavior and economics of beach going (Pendleton and Kildow 2006). A review of the literature on non-market values of coastal recreation in California shows that most studies have focused on beach goers. These studies often group beach users into broad categories that do not account for nuances in behavior or preferences that drive choices about coastal recreation. Understanding how specific groups use the coast and are affected by environmental changes is necessary to protect coastal recreation.

Small or difficult to monitor groups of beach users that have unique interests, such as surfers, divers and kite boarders, represent a unique challenge to survey based research. They are hard to identify in random samples of the population, their use has high spatial and temporal variability, and they may have a low response rate to in-person interviews (Shaw and Jakus 1996; Hanemann, Pendleton et al. 2004). Surfers are representative of a "hard to measure" user group because their numbers are too small to capture by random samples of the population (except for surveys that have extremely large numbers of responses), they have a low response rate to on-site surveying, and they use the coast at times that are different than other beach goers. As a result surfers are often underrepresented in beach going surveys. Surfers were found to represent up to 20% of beach visits at certain Orange County beaches in early morning intercept surveys (Chapman and Hanneman 2001) but represented only 3% of all beach goers in the Southern California Beach Valuation project survey using a random digit dial (RDD) survey.

Using a conservative approximation, it is estimated that there are 150 million beach visits per year in California resulting in economics impacts that could exceed $3 billion and consumer surplus values that could substantially exceed $2 billion (Pendleton and Kildow 2006). It is often assumed that beach recreation studies include surfers. However, it is likely that surfers are underrepresented in these surveys and that they may represent a significant beach going population that is not included in studies of beach recreation (Chapman and Hanneman 2001). Nelsen, Pendleton et al. (2007) estimated the economic impact of surfers visiting Trestles to the City of San Clemente to be between $8 million and $13 million. This contribution was not captured in the King (2001) report on economic impacts from San Clemente beaches and was likely considered to be zero prior to the study.

It is important to distinguish surfers from beach goers in economic research and in coastal zone management because surfers are substantially different than the general beach going population. Surfers tend to visit the beach at different times than regular beach goers. Surfers often visit the beach in the early mornings and in the evenings because these are times when the conditions are at their best (Nelsen, Pendleton et al. 2007). In contrast beach goers tend to visit the beach in the middle of the day and this is when most estimates for beach visitation are taken and when most beach use surveys are conducted (Chapman and Hanneman 2001; Hanemann, Pendleton et al. 2004).

Surfers are more avid than typical beach goers. Although surfers are a small percentage of the overall beach going population their avidity may result in a higher number of visits than beach goers. As part of the 2000 National Survey on Recreational and the Environment, Leeworthy and Wiley (2001) found that California beach goers average 12 visits per year and surfers averaged 20 visits per year. They estimated that California surfers make 22.6 million visits per year (more visits than recreational fishing). There is evidence to suggest that 20 visits per year may be conservative for high quality surfing areas. Nelsen, Pendleton et al. (2007) found that 38% of surfers surveyed visited Trestles over 100 times per year. Leeworthy and Wiley (2001) estimate of 22.6 million surfing visits, which represents approximately 15% of the estimated 150 million beach visits per year. Chapman and Hanneman (2001) made a special effort to intercept surfers by surveying 22 Southern California beaches from 6:00 a.m. to 6:00 p.m. and found that the proportion of beach trips accounted for by surfers ranged from 10-18%. This portion of the beach visiting population may be missed in most beach valuation studies.

Surfers make choices about where to go to the beach based on reasons that are different than other beach goers. Beachgoers are influenced by access, amenities and aesthetics and therefore have many choices for their beach destinations in California (Hanemann, Pendleton et al. 2004). This may be especially true in Southern California because of the large number of accessible, high quality beaches with amenities. In contrast, surfers are extremely particular about their beach choice based on numerous oceanographic, meteorological, surf and social conditions. As a result, environmental impacts such as water quality impairment or changes in beach processes from coastal development will likely impact the beach choice, and thus the economic values and contributions, of surfers differently than other beach goers.

Surfing areas are sensitive to environmental changes resulting from natural geomorphologic changes and human interruption of natural coastal systems (Walker 1974; Scarfe, Elwany et al. 2003). Subtle changes in conditions can affect the desirability of a particular surfing area. Surfers are also affected by water quality impairment more severely than beach goers. Many beach goers are not affected by water quality conditions because they do not enter the water. Dwight (2007) found that average bathing rates varied from a minimum of 26% of beachgoers in winter months to a maximum of 54% during the summer. When surfing, all surfers are completely immersed in the ocean so they are fully exposed to all water quality conditions. Stone (2008) found that surfers ingested an average of 170 ml (6 ounces) of seawater per visit. This volume of water intake is markedly high than those for swimmers (16-37 ml) and divers (10 ml).

Ingesting water can impact the health of surfers (Dwight, Backer et al. 2004; Given, Pendleton et al. 2006; Wade, Calderon et al. 2006).

Coastal development that is permitted by the California Coastal Commission is required to be protective of coastal access and coastal recreation. It is important to understand how coastal development may pose threats to surfing that may be different from the general beach going population. Due to the specific conditions required for surfing, there are fewer substitute sites for surfing than beach going. Impacts to surfing areas such as closures due to water pollution may impact surfers more than other beach goers (Chapman and Hanneman 2001).

Despite the popularity and cultural influence of surfing in California, relatively little is known about surfers and the economic values associated with surfing. To date there are only two peer reviewed and published studies that address the non-market value of surfing (Lazarow, Miller et al. 2007). Oram and Valverde (1994) describe the methodology used by the Surfrider Foundation to argue for mitigation of lost surfing due to the construction of a large groin in El Segundo, California. By comparing the entrance fee of a water park, they estimated a value of a surfing visit to El Segundo at $16.95 ($1991) per person per visit. Multiplying this value by the estimated attendance over four years, they estimated that the lost surf resulted in damages worth $244,000 to local surfers (Oram and Valverde 1994).

Chapman and Hanneman (2001) included the non-market value of surfing to estimate the economic value of lost recreational opportunities from the *American Trader* oil spill off of Huntington Beach, California. Their results were based on a benefits transfer approach. They could find no existing literature on the value of a surfing day because there were no peer-reviewed publications on the non-market consumer surplus of surfing. As a result they were not able to base their valuation of surfing on empirical evidence. Instead, they based their estimated value on expert opinion from the Surfrider Foundation and comparison with other specialized beach uses (Chapman and Hanneman 2001). They first assumed that a surfing day was valued at $16.95 ($1990) per surfing trip, which was about 30% over their estimate for general beach recreation (Chapman and Hanneman 2001). With the addition of new data sources on the value of beach visits but not specifically on surfing, Chapman and Hanemann (2001) refined their estimate value for a surfing day to be 25% higher than the consumers' surplus for general beach recreation and used a value of $18.75 per trip ($1990) for surfing trips lost.

One reason that so little is known about surfers is that they are difficult to survey. Random phone surveys are impractical because of the relatively small population of surfers and their non-random distribution in the state. Further, surfers often visit beaches at different times than other beach users and have proven difficult to intercept through in-person surveys (Chapman and Hanneman 2001; King 2007). As a result, surfers have been grouped generally with beach goers in beach visitation research (with the exception of Chapman and Hanemann (2001)) and when considering the impacts that coastal policy will have on recreation. Distinguishing surfers from other beach goers is necessary to estimate the consumer surplus of surfing waves because surfers have highly specific preferences, avidity and visitation patterns. Surfers may respond to impaired water quality similarly to other water users who immerse themselves, but their substitution options are more limited. Compared with general beach goers, only half of which may enter the water (Dwight, Brinks et al. 2007), they are likely to respond to management decisions differently than other beach goers. Surfing also has a higher non-market value per visit than general beach going (Chapman and Hanneman 2001).

To better capture information about surfers, I use an Internet-based approach to collect data on surfers at Trestles Beach, a famous surf break near San Clemente, CA. Using these data, the non-market consumer surplus of surfing at Trestles Beach is estimated. I find that consumer surplus values for a visit to surf at Trestles are within the range of other coastal recreational use values but higher than beach visit values (Leeworthy 1995; Chapman and Hanneman 2001; Pendleton and Kildow 2005) (See Table 2.3). This is expected given high desirability of surfing at Trestles and the large distances that surfers are willing to travel to surf there. Trestles is representative of other high quality surfing areas in California that may generate similar non-market values.

Internet-based survey instrument

This study uses data from surfers who visited Trestles Beach in San Clemente, CA during the summer of 2006. The data were collected using an Internet-based survey instrument. After testing paper surveys on surfers and researchers, an anonymous opt in Internet-based survey was created. The survey responses came primarily through advertisements on surf forecasting websites and via email to local area surfers. The survey was conducted from late June through September 2006. During this period, 1006 surveys were collected and 971 were deemed usable. The survey instrument collected a wide variety of information from the respondents, including information on surfing background, surfing visitation, and travel behavior and demographics.

The survey instrument included over 40 questions; many were multi-part and resulted in 127 data points per respondent. Data collection methods are explained in more detail in Nelsen, Pendleton et al. (2007). This study was able to capture a large number of highly detailed responses from surfers by using an Internet-based survey, but Internet-based surveys have known issues that limit their ability to generalize responses to a larger population (Couper 2000). These limitations include sampling error, coverage error, and non-response errors and limitations to extrapolating internet-based surveys to a larger population. See Chapter 3 for a discussion of these limitations.

Methods

To estimate the non-market consumer surplus of a surfing visit to Trestles, we use the single site travel cost method (TCM). Two common methods for estimating the consumer surplus of non-market goods are stated preference models and revealed preference models. In state preference models users are asked questions about how they value a non-market good. In revealed preference models, values are estimated by observing the behavior of users (Parsons 2003). The TCM is a well-established revealed preference model.

The premise of the TCM is that the distance a visitor must travel determines the number of visits made to a site. Visitors live at different distances from Trestles and therefore face different prices (or travel costs) for visiting the beach. Visitors who live far away and pay higher travel costs visit less often. Visitors who live closer and incur lower travel costs visit more often. Economic theory says that, *ceteris paribus*, if costs are higher, surfers should take fewer trips. By comparing travel costs and the number of trips, a downward sloping demand function for recreational is revealed (Parsons 2003)(See Figure 1.3).

The dependent variable in our travel cost model is the number of visits that a surfer makes. To generate the demand function, the number of trips an individual surfer takes over a one-year period is modeled as a function of travel cost and other explanatory variables. This approach is called a count data model. A count model requires that the variable for number of trips is always a non-negative integer.

The model used to estimate the relationship between trips taken and cost of a trip depends on the statistical distribution of these trips across different surfers (e.g. normal, log normal, Poisson, negative binomial.) It is commonly assumed that recreation trip counts have a Poisson distribution, and thus a Poisson regression (Parsons 2003) is often used to model recreational trip count models. The Poisson distribution is characterized by its probability density function given by

$$\Pr(X = x) = \frac{e^{-\lambda}\lambda^{x}}{x!}, x = 0,1,2,...$$

Equation 1.1 Poisson distribution

The parameter λ is both the mean and the variance of the random variable X, trips to the site, and therefore is always a non-negative value. For many surfers in the general population, the number of trips to Trestles will be zero. By design, our survey instrument required at least one visit, so surfers who did not visit the site are missing in our data set. The lack of data on surfers who made no trips to Trestles is known as truncation. The data is truncated because the survey only intercepted individuals who surfed at Trestles and did not sample the entire population of surfers (Parsons 2003).

Because it is necessary that $\lambda > 0$, it is common to model the conditional mean as an exponential function: $\lambda = \exp(z\beta)$ where z is the vector of demand arguments β the vector of parameters. The parameters are estimated by maximum likelihood estimation (Haab and McConnell 2002; Parsons 2003; Bin, Landry et al. 2005).

The Poisson model assumes that the conditional mean and variance are equal, an assumption that often is violated in recreational data (Haab and McConnell 2002). For recreational trip data, the variance is often larger than the conditional mean - a condition called overdispersion. For our data, the mean and variance of the trip data are 109 and 10571, respectively. When overdispersion in the trip count data exists, the negative binomial model is commonly used to estimate count models. To account for overdispersion in the Trestles count model, the negative binomial model is estimated, which also provides a test for overdispersion (Cameron and Trivedi 1998).

The negative binomial model distribution is given by

$$\Pr(x_i) = \frac{\Gamma\left(x_i + \frac{1}{\alpha}\right)}{\Gamma(x_i + 1)\Gamma\left(\frac{1}{\alpha}\right)} \left(\frac{\frac{1}{\alpha}}{\frac{1}{\alpha} + \lambda_i}\right)^{\frac{1}{\alpha}} \left(\frac{\lambda_i}{\frac{1}{\alpha} + \lambda_i}\right)^{x_i}$$

Equation 1.2 Negative binomial model

where $\lambda = \exp(z\beta)$. The parameter α can be used as the overdispersion parameter (Haab and McConnell 2002). When α is zero, the NBM is equivalent to the Poisson model. If α is greater than zero, then the NBM is more appropriate. For the Trestles visitation data, α was 0.81 (.04). This suggests that the NBM is preferable to the Poisson due to overdispersion (Haab and McConnell 2002). Both estimations are show in Table 1.1 for comparison.

I estimated the value of a single trip to surf in terms of the consumer surplus enjoyed by the surfer. Consumer surplus represents the value captured above cost of travel that the surfer attains when surfing at Trestles (See Figure 1.3). Consumer surplus, the measure of the net economic value of beach going to the beachgoer, is a common economic measure of the willingness to pay, beyond any costs incurred, of an individual to participate in a recreational activity. In this case we are estimating the consumer surplus of surfing at Trestles.

Consumer surplus is given by:

$$\hat{S} = -\frac{\hat{\lambda}}{\hat{\beta}_{tc}}$$

Equation 1.3 Consumer surplus

We calculate consumer surplus using both the Poisson and NBM for comparison. (See Table 2.2).

Time and travel costs

There are three possible components to be considered when calculating the cost of visiting a site. The most straightforward cost is the out-of-pocket costs of traveling to and from the site. Out-of-pocket travel costs include the cost of fuel, and automobile maintenance and depreciation. The other two travel costs are based on the opportunity cost of time spent traveling to and from the site and the opportunity cost of time spent on the site.

Out-of-pocket travel cost (*optc*) is determined by multiplying the fuel costs, and maintenance and depreciation costs by the round trip mileage associated with each individual visit. Mileage costs were determined using the American Automobile Association estimate for the summer of 2006 ($0.445/mile). For this study, the survey instrument asked for the respondent's address and for estimated distance traveled and estimated time spent traveling. Google Maps was used to calculate the actual distance traveled and time spent traveling by entering the respondent's address and the parking lot at Trestles.

The appropriate way to incorporate the opportunity costs of travel time and time on site is still debated in the literature. For a review see Lew and Larson (2005). New mechanisms to more accurately determine these opportunity costs have been developed, but they significantly complicate the model and require data not collected in our survey (Shaw and Feather 1999). It is common in the recreational demand literature to use a fraction of an individual wage as a proxy for the shadow cost of leisure time. Here the opportunity cost of travel time (*tt*) and the opportunity cost of time on site (*tos*) are estimated using one third of the hourly rate for individuals multiplied by their travel time (Shaw and Feather 1999; Hanemann, Pendleton et al. 2004). An individual's hourly wage is determined by dividing individual annual income by 2080 hours per year of work or using their stated hourly wage (Cesario 1976). Taking a conservative approach, individuals who did not report income were given an hourly wage of zero.

Total travel cost (tTC) can be estimated by combining the out-of pocket costs, travel time costs and on-site time costs.

$$tTC = optc + tt + tos$$

Consumer surplus estimates are presented for TC using three values incrementally, (a TC_1=optc only, b) TC_2=optc + tt, and c) TC_3=optc+tt+tos. Table 3 shows how the inclusion of the opportunity cost of travel time and time on site increases the average consumer surplus of a visit. The TC_2 is used for the final annual estimates because it is the standard approach.

Challenges and limitations of the single site travel cost method

A common problem with recreational data when a sample is drawn from an on-site survey is that more frequent users are more likely to be surveyed. This problem is known as endogenous stratification and can create bias and inconsistency with the results of the analysis (Shaw 1988). One of the qualifying questions for this survey instrument required that the respondent had surfed in the last 24 hours. This qualifier selects for people that surfed within 24 hours of viewing the Internet-based-survey instrument and may select for more avid users because the more avid users are more likely to qualify. This could create endogenous stratification. Endogenous stratification is accounted for in the NBM model used for this study.

A limitation of the single site TCM models is accounting for substitution. Substitution is the ability to choose another surfing site, if Trestles is closed or if the wave quality is reduced. Substitution can reduce the consumer surplus of a site and is not captured using a single site TCM model. Chapman and Hanneman (2001) found that substitution for surfing at Huntington Beach was limited for approximately 50% of the surfers because they did not have time in the morning before work to seek an alternative surfing area. In some cases, substitution for a different site incurs the loss of consumer surplus due to increased cost of travel. To reflect this cost, Chapman and Hanemann (2001) used $12 per trip as their estimate of the average loss of consumer surplus for surfing trips that were diverted to substitute sites when Huntington Beach was closed. Trestles is considered one of the best surfing waves in the continental United States and does not have a comparable substitute that is less than 30 miles away.

The NBM has the advantage of being a closed for solution for the average consumer surplus per trip. This means that the CS can be calculated precisely. Other functional forms where the choke point (point at which trips equal zero) is asymptotic cannot be used to calculate the average or total consumer surplus accurately. The NBM has these properties because of assumptions made about the choke point (Englin and Shonkwiler 1995; Hilbe 2005). In practice, TCM models are best used to estimate marginal changes in trip availability. Here we estimate the CS for surfing at Trestles to show the approximate consumer surplus value of trips to Trestles.

Results

We estimate the non-market consumer surplus value of surfing for survey respondents at Trestles Beach near San Clemente, CA. The single site travel cost method was used to estimate the demand for surfing at Trestles. The high quality waves at Trestles attract surfers from all counties in Southern California (See Figure 2.5). Figure 2.6 shows that surfers who live closer to Trestles visit more often. This is a necessary assumption of the TCM and is verified in the model results below.

Both the Poisson and the Negative Binomial Model (NBM) were used to estimate recreational demand. Estimation results of the recreation demand models are listed in Table 2.1. The parameter α in the NBM was greater than 1 (α=0.81) suggesting overdispersion, therefore the NBM is preferred to the Poisson model for our data (Haab and McConnell 2002). In both cases, the coefficient for travel cost (travelcost) is negative and significant, indicating that the number of trips is inversely related to travel cost. This implies a downward sloping demand curve, as required by the travel cost model. While all variables except full-time employment status (fulltime) appear significant in the Poisson model, only high income is moderately significant in the more appropriate NBM model. Haab and McConnell (2002) warn that the Poisson model can be deceptive in giving standard errors that are too low.

The estimate for consumer surplus for surfing at Trestles using the NBM is $115 ($2006) per person per visit. Accounting from endogenous stratification reduces the consumer surplus to $114. Using the Poisson model, the consumer surplus estimate is $94 ($2006) per person per visit (Table 2.2).

Inclusion of the opportunity cost of travel time and time onsite will shift the demand curve and increase the consumer surplus. The addition of these costs is still debated in the literature. Table 2.3 shows the increase in consumer surplus by adding the opportunity costs associated with an individual's travel time (*tt*) and time on site (*tos*) to the out-of-pocket costs (*optc*). Including time-on-site results increases the average consumer surplus value by almost $94. Given that most surfers at Trestles surf either before or after work, time on site is not included in our final consumer surplus estimates (Nelsen, Pendleton et al. 2007).

TC_1 and TC_2 are four to five times higher than the non-empirical value estimated by Chapman and Hanneman (2001) but are within the range of consumer surplus estimates for San Diego beaches (See Table 1.4). Chapman and Hanneman (2001) valued surfing at Huntington Beach at $28.93 ($2006) per person per visit by basing the value on 125% of a beach day. Leeworthy (1995) estimated the value of San Onofre State Beach (a very popular surfing beach) and San Diego beaches generally as having values of $88 and $93 per person per visit, respectively. Pendleton and Kildow (2005) summarized surplus values for beach visits in California from the literature and found a range from $15 - $52.

Based on a conservative value of $138 per visit and a total of 106,000 annual visits in 2006 captured through our Internet-based survey, the annual economic value for the subset of surfers we sampled is estimated to be $14.6

million per year ($2006). The California State Parks lifeguard department records high quality annual attendance data for Trestles (Nelsen, Pendleton et al. 2007). They report that the annual surfer visits to Trestles in 2006 was approximately 330,000. The estimated per visit value ($138) cannot be extrapolated to this entire population of surfer visits because our sample is not random. A benefits transfer approach can be used to estimate a range of values (Pendleton 2008). Using $29 as a conservative value from Chapman and Hanneman (2001) and $138 found in this paper, a range for the annual economic value for surfing at Trestles for the trips not accounted for by our survey respondents (224,000 visits) can be estimated. This results in an additional value that ranges from $6.5 to $30 million per year. Adding this range to the annual consumer surplus for the respondents results in a total consumer surplus value that ranges from $21 to $45 million per year ($2006).

It is important to note that this paper estimates the non-market economic value of surfing at Trestles, which is only a portion of the total economic value of surfing at Trestles. Total economic value is framework to describe the use and non-use values associated with the recreational resource (See figure 1.3). Surfing is a use value. Non-use values include existence and option values. These values represent the willingness to pay of people who will never use the resource but benefit from the knowledge that the resource exists in a healthy state and can be enjoyed by future generations (NRC 2004). The existence and option values of surfing at Trestles may be important because of its iconic status. It may not be as important for other lesser-known surfing areas.

This paper also does not report on economic impacts (expenditures made by surfers). The economic impacts to the City of San Clemente were estimated in Nelsen, Pendleton et al. (2007). They found that the average expenditure was $40.20 per person per visit and estimated a range of economic impacts generated from visitors to Trestles on the City of San Clemente to range from $8 to $12 million per year ($2006).

Conclusions

This paper provides an estimate of the consumer surplus for surfing at Trestles beach near San Clemente, California. A single site travel cost method was used with data collected from an Internet based-survey. The results show that high quality surfing areas attract surfers who are willing to travel large distances or exhibit high avidity if they live close by. As a result, they generate large consumer surplus values per visit ($138/person/trip). The combination of this high consumer surplus value and high use (330,000 visits/year) creates an annual economic value for surfing at Trestles that ranges from $21 million to $45 million per year ($2006).

Internet-based survey instruments can collect data on "difficult to survey" coastal users for use in the economic valuation. In a ten-week period, the Internet-based survey instrument generated 973 valid responses from surfers at one beach and collected data on over 40 questions, resulting in 127 data points per respondent. Using an Internet-based survey provides a low cost mechanism to collect a large number of survey responses but limits extrapolation of the results because the results are non-random and may be biased (Couper 2000). There is a tradeoff to be considered between having an unbiased survey with small number of responses (and hence large margin of error) and having a potentially biased survey with a large number of responses and thus a small margin of error.

Further research using short, randomized on-site surveys could be used to “ground truth” the Internet surveys and to provide a basis to extrapolate the Internet-based surveys to better characterize surfer demographics, visitation patterns and economic impacts (See Chapter 3).

The single site TCM provides an estimate for the for the non-market use value of the site for surfing. Single site travel cost models are less powerful when trying to measure how environmental change will affect the value of a site. Further research using multiple surfing areas in Southern California or site choice models could provide insight into how environmental change would affect values of surfing. Surfers visiting Trestles have many choices in their surfing destinations and many surfers who live near quality surfing areas are willing to incur additional costs to visit Trestles. Although other substitute sites in the area are inferior, changes in water quality or quality in the surf break at Trestles could lead surfers, most of whom live closer to other high quality surfing areas, to stay closer to home.

We find that surfers are an important and poorly understood segment of the beach going population. Previous studies have shown that surfing is highly sensitive to environmental conditions and surfers have many choices, so changes in the environmental and surfing quality of a beach site will likely result in reduced visitation.

Coastal management decisions that will impact surfing areas and water quality should explicitly consider the impacts to surfing and recognize that surfing areas attract an important user group that contributes expenditures to the local community and generates relatively large economic values.

Variable	Poisson Coefficients (standard error)	Negative Binomial Coefficients[a] (standard error)
travelcost[1]	-.0106143 (0.000)	-.0087561 (0.000)
age	-.0011612 (0.033)	-.0010711 (0.841)
yearsurfing	-.0028584 (0.000)	-.0023983 (0.644)
expert	.1734659 (0.000)	.1778206 (0.113)
highincome	.1717046 (0.000)	.1492715 (0.063)
highedu	-.0814041 (0.000)	-.0825688 (0.298)
fulltime	.0097928 (0.291)	-.0275131 (0.765)
_cons	4.938367 (0.000)	2.753323 (0.000)

a) accounting for endogenous stratification and truncation. 1) travel cost =*optc* only

Table 2.1 Estimation results for the Poisson and negative binomial demand model.

Model	**Consumer Surplus Estimate**[1] Value per person per visit ($2006)
Poisson	$94
Negative Binomial	$114

1) travel cost = optc only

Table 2.2 Consumer surplus values for the Poisson and NBM models for surfing at Trestles.

Model	**Consumer Surplus Estimate** Value per person per visit ($2006)
TC_1= *optc*	$114
TC_2= *optc +tt*	$138
TC_3= *optc + tt +tos*	$232

Table 2.3 Consumer surplus values for travel cost, travel time cost and time on site.

Data Source	Consumer Surplus/Visit (Adjusted $2006)
CA Beach Goers[1]	$15.00 - $52.00
San Onofre State Beach[2]	$88.14
San Diego Beaches[2]	$93.50
Huntington Beach Surfing[3]	$28.92
El Segundo Surfing[4]	$25.09
Trestles Surfing	$138.00

1) Pendleton & Kildow, 2006 2)Leeworthy, 1995 3)Chapman and Hanemann, 2001
4) Oram and Valverde, 1997

Table 2.4 Comparison of consumer surplus per person per visit.

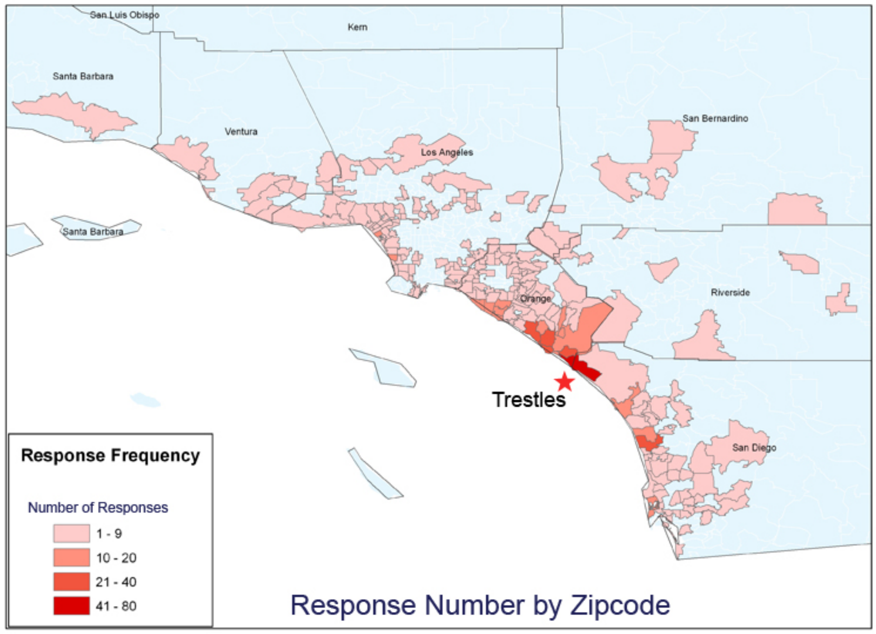

Figure 2.1 Response to survey instrument by zip code.

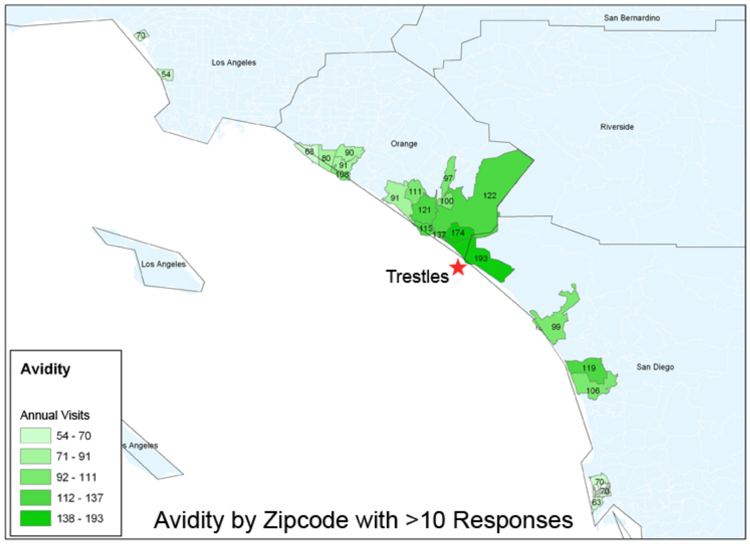

Figure 2.2 Average annual visits to Trestles for zip codes with more than 10 respondents.

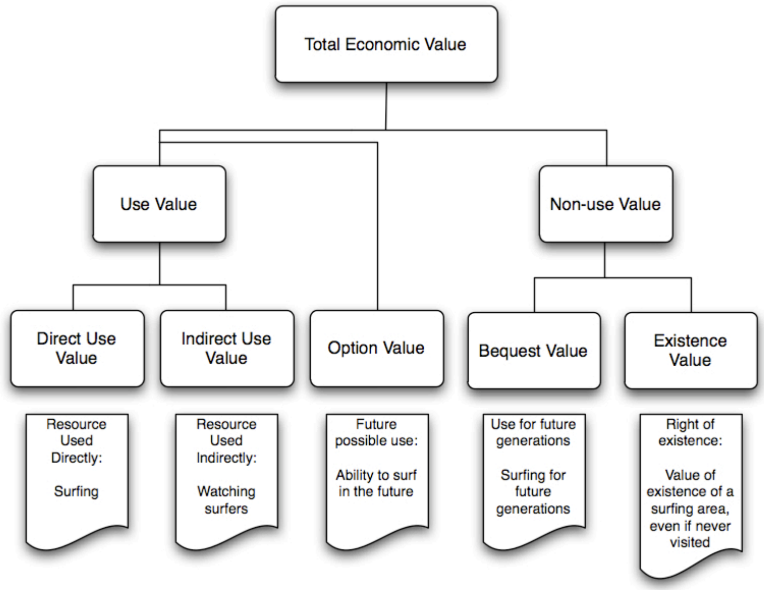

Figure 2.3 Total economic value framework with examples from surfing.

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Chapter 3

Impact of survey mode on the socioeconomic characterization of surfers at Trestles

Introduction

Surveys are the instrument that environmental economists use to gather information about recreational preferences, behavior and demographics of people who visit the coast for recreation. This information can be used to better understand the economic impacts and values of coastal recreation and how those values may change as a result of coastal management decisions. "In person" surveys (also known as intercept surveys) of coastal recreation are commonly used, but they are expensive and time consuming because there are often many coastal access points that must be monitored over long periods at all times of day. Intercept surveys may also miss difficult to survey but important users groups. For example, surfers often decline "in person" interviews and tend to use beaches in the early morning and evening hours, times that are not typically sampled in surveys of beach goers (Chapman and Hanneman 2001; King 2007). Other groups, like free divers, may use the beach at night. Because private coastal users are difficult to survey, we consequently have very little information about these users, their preferences and the economic contributions they make to local coastal economies. Because these users are an important component of the larger set of coastal users, it is important to develop new techniques to be able to survey these potential respondents.

Internet-based surveys are becoming increasingly popular because of their ease of use and cost savings. Urban areas and areas of high levels of income or education have a high degree of Internet use by households (Berrens, Bohara et al. 2003). In these areas, coastal visitors could potentially be targeted through random Internet surveys of the larger population (a technique known as eRDD. For an example, see http://www.insightexpress.com). Specialized sub-groups of coastal visitors may exhibit even higher use of the Internet (a term referred to in the literature as Internet penetration). Increasingly, specialized user groups such as divers, kayakers and surfers, communicate and gather meteorological and oceanographic information using the Internet. Use of Internet-based survey instruments that advertise on recreational web sites may facilitate responses from difficult to survey or hard to reach user groups. Internet surveys offer several important advantages. They are a relatively inexpensive way of reaching specialized respondent groups. Because they are inexpensive, large numbers of responses can be collected which ultimately reduces the margin of sampling error associated with surveys. Internet surveys also offer flexibility for the respondents who can take the survey at their leisure and even start and stop and restart a survey. Internet surveys also offer a platform for presenting maps, photos and other digital information. Finally, Internet surveys provide personal anonymity, which may increase the accuracy of responses and reduce interviewer bias (Dillman, Smyth et al. 2009).

Because the use of the Internet for economic surveys is new, there are concerns about biases associated with Internet-based surveys and the effect they may have on valuation estimates (Couper 2000; Fleming and Bowden 2007). Couper (2000) identifies coverage error, non-response error and sampling error as the major limitations to extrapolating results from Internet-based surveys to a larger population. Of course, there are no perfectly representative surveys and the question is whether we understand the biases of Internet surveys and how these biases compare to other methods of survey administration. Mail surveys have historically had trouble with low response rates and an inability to track transient respondents. As more households give up wired telephone service and exclusively use cellular phone service, telephone-surveying techniques face similar challenges with responses and respondent biases (Dillman, Smyth et al. 2009).

The purpose of this chapter is to improve our understanding of the suitability of Internet-based survey instruments for economic valuation of specialized coastal recreation. The advantages and disadvantages of Internet-based survey instruments are described. Using a case study of surfers at Trestles, we compare Internet-based surveys to an intercept survey on respondent demographics, economics impact and willingness to pay (WTP) for access to Trestles (consumer surplus).

Survey mode: the use of Internet-based surveys for environmental valuation

The conventional modes for administration of economic valuation surveys are on-site, in-person surveys (intercept surveys), random digit dial (RDD) telephone surveys, mail back surveys and combinations of the above (Dillman, Smyth et al. 2009). More recently, Internet-based surveys have become increasingly popular, particularly in sociological and marketing research, but their use in environmental valuation research remains limited (Marta-Pedroso, Freitas et al. 2007).

Internet-based survey instruments use several methods to recruit participants. They include email solicited surveys, panel surveys and voluntary web-advertised surveys (also known as opt-in surveys) and in-person recruitment to participate in online surveys (Dillman, Smyth et al. 2009). Email solicited survey instruments use an email list that ideally represents a targeted group of respondents. These are often performed at universities or through large pre-selected email lists. Panel surveys are conducted using a random sample of a large collection of pre-selected volunteers who have agreed to participate in surveys. Several private services (notably Knowledge Networks and Harris Interactive) offer panels that are supposed to be representative of the general population. Web-advertised surveys use advertisements or links on commonly used websites to recruit voluntary participation in the survey. All of these methods are challenged with representativeness of the general population (Dillman, Smyth et al. 2009).

A key question about using Internet-based surveys is whether the population of Internet users is different than respondents found using traditional survey modes or from the larger target population. There is little agreement in the small number of Internet-based economic valuation studies regarding general demographic patterns of Internet-based respondents compared to other survey modes (Table 3.1). The use of Internet surveying for economic valuation is still new and will benefit from additional studies to better describe the differences and best practices to improve results.

Fleming and Bowden (2007) is the only study found in the peer reviewed literature that compares web-based and mail survey administration modes for a revealed preference non-market valuation. They compared the two survey instruments using the zonal travel cost method to estimate consumer surplus of visits to Fraser Island in Australia's Gold Coast. The Internet survey was advertised on common tourist websites to recruit voluntary participation. The mail survey was handed to visitors to be mailed in after their visit.

Fleming and Bowden (2007) compared response rates and found them to be similar between the two survey modes. They calculated the web-based response rate by comparing the number of hits to their survey web page with those that filled out the survey.

The two modes showed similar demographic profiles. There was no observable difference (at the 95% level of significance) between gender, mean age and education of the respondents. Respondents from the mail survey report higher mean household income. Consumer surplus values were also similar. The consumer surplus value for the mail sample was 7.4% higher ($417million per annum) than the web-based sample ($405 million per annum) but well within the standard error of the estimations ($166 million and 196 million, respectively).

They conclude that an Internet-based survey is a promising method for economic valuation (Fleming and Bowden 2007).

Marta-Pedroso et al. (2007) compare "in person" interviews with an Internet-based survey using the contingent valuation method to estimate willingness to pay for the preservation of the cereal steppe in Southern Portugal. They found the Internet-based survey respondents to be younger, better educated and reported higher incomes than the "in person" surveys. Contrary to expectation given the demographic differences, they found that respondents surveyed through the Internet were more likely to state a lower willingness to pay than those interviewed in person. They conclude that Internet-based surveys are promising for contingent valuation but that further research is needed (Marta-Pedroso, Freitas et al. 2007).

Berrens et al. (2003) compare telephone surveys with Internet surveys that used panels of pre-selected and willing respondents in a contingent valuation study of the willingness to pay of the U.S. population for ratification of the Kyoto protocol. They find the gender and mean age similar across modes. Respondents from the telephone survey are more educated. Contrary to the common finding that Internet users tend to have higher incomes, Berrens et al. (2003) found that the Internet panel respondents reported lower household income than either the telephone respondents or the general population.

These findings reveal no clear pattern when comparing the demographics of Internet-based survey respondents to traditional survey modes. The results do suggest that Internet-based surveys may yield more conservative estimates of willingness to pay (WTP). Economic valuation research to compare Internet survey with other survey modes is limited and will benefit from more research.

Advantages and disadvantages of Internet-based surveys

Internet-based surveys have advantages over other survey modes. The most commonly cited advantage is lower costs for survey implementation than with telephone, mail or in person survey modes. Internet surveys have the ability to reach large numbers of respondents quickly and provide an opportunity to enrich the survey with images, maps and interactive features. Marta-Pedroso (2007) note that Internet-based surveys offer privacy and time to answer questions thoroughly. Internet surveys are also able to reach small, hard to contact groups (Berrens, Bohara et al. 2003).

There are still concerns about the validity of Internet-based survey instruments. The primary disadvantage is that the error properties are not well understood. Couper (2000) identifies coverage error, sampling error and non-response error as the major limitations to extrapolating results from Internet-based surveys to a larger population.

Coverage error occurs when the target population is different from the frame population (Couper 2000). The target population is the population about which we are making an inference. The frame population is group from which we sample and then extrapolate to the target population. In the case presented here, the target population is all surfers who visit Trestles. The frame population is surfers with Internet access. Coverage error can occur when the population with Internet access is significantly different than those without Internet access, resulting in a non-random exclusion of individuals (those without Internet access) from the sample frame. In most populations there are social and geographic differences in access and use of the Internet (Fleming and Bowden 2007).

Sampling error can result if the sample of the frame is different from the total population of the frame. If the random sample of the frame is not representative of the frame, then sampling error will occur. This poses a challenge in many Internet-based surveys because the frame is unknown and the sample is not selected at random from the frame. A non-probability design limits the ability to generalize to a larger population (Couper 2000).

Non-response error is a bias introduced when respondents within the sample frame have different characteristics or behaviors than those that don't respond (Fleming and Bowden 2007). For surveys where the frame cannot be identified (the denominator of those eligible to participate is not known), the non-response rate cannot be calculated. Fleming and Bowden (2007) compared the number of hits to their survey web page with the number of responses to calculate a response rate and found that the Internet-based survey had a slightly higher response rate than their mail survey.

Methods

Survey design and data collection

Three data sets are used to compare survey year and mode for determining the demographics, recreational use, expenditures and non-market consumer surplus for surfing at Trestles Beach.

An Internet-based survey instrument collected data during the summer of 2006 that included 973 valid respondents and is described in detail in Chapter 2 and in Nelsen, Pendleton et al. (2007). Another smaller Internet-based survey data set (75 respondents) was collected during the summer of 2008. The Internet-based survey instrument from 2008 was part of a larger survey designed to collect information on surfing at 22 surfing areas in California over a 1-year period. This survey ran from September 2007 through October 2008 and collected over 1500 responses and was advertised using the same methods as the 2006 survey. Between June and September 2008, 75 surfers who responded to this statewide survey visited Trestles. The on site survey intercepted surfers at the primary access to Trestles between June and September 2008 and collected 335 responses. This survey data was collected using a schedule based on randomizing the day of the week and during random 2-hour periods that ranged from 6:00 a.m. to 6:00 p.m. Survey data were collected from every third surfer as they exited the beach. Surfers who cycle to the beach (a common practice, particularly for avid local visitors) where disproportionately excluded because they did not want to stop to be surveyed.

Comparison of survey mode and year

The two Internet-based survey instruments are compared with the on site intercept survey for surfers visiting Trestles Beach. The large Internet-based survey with 971 respondents was collected two years prior to the intercept survey. The second Internet-based survey was collected simultaneous with the intercept survey but the number of respondents is small (75 respondents). It is presumed that in the general demographics, expenditures of surfers and non-market values associated with surfing at Trestles did not change significantly over a two-year period with one notable exception: the price of gas spiked over the summer of 2008, making visits by car more expensive. This could affect who is visiting Trestles and thus the demographic characteristics of the respondents from the 2008 data.

These data are used to compare survey responses by year (2006 and 2008) and by survey mode (Intercept and Internet-based). Survey mode is compared using 2006 Internet-based survey with the 2008 intercept survey because they are the two largest data sets. Respondent demographics, recreational use, expenditures and non-market consumer surplus values are compared. To test for statistical significance, demographic variables across the data sets are compared using the t-test or the Chi-squared test (Fleming and Bowden 2007). The t-test is used for continuous variables, and the Chi-squared test is used for cross-tabulated variables. The demographic variables compared are age, highest educational attainment, employment status, percentage of high-income respondents and gender. The high-income variable was used because the income categories were different across the three survey instruments. High income is defined as annual personal income equal to or greater than $75,000 or annual household income equal to or greater than $100,000.

Two recreational use variables that are important in the travel cost model were compared across survey mode. Experience, reported here as number of years surfing, is a common demand shifter in travel cost models (Parsons 2003). Avidity is the number of visits reported by the respondent for the year prior to the survey response date. The number of visits is important because it is the dependent variable used in travel cost models.

Economic impacts, consumer surplus and travel related variables are compared between survey year and mode. Economic impacts are compared using reported average daily expenditures per visit. Consumer surplus is calculated using the travel cost method (See Chapter 2 for an explanation of the travel cost methodology).

The travel cost method (TCM) uses travel costs, demographic and recreational use variables to model demand to estimate willingness to pay (for a more complete description of the travel cost method, see Chapter 2). The TCM uses annual trips per person (avidity) as the dependent variable and uses travel cost and other explanatory variables that may affect demand. Travel distance for the 2006 Internet-based survey data is based on individual addresses of the respondents. Travel distance for the 2008 Internet-based survey and the 2008 intercept survey use the average distance traveled by zip code from the 2006 travel distance data.

One exogenous factor that is independent of survey mode that changed between the summer of 2006 and 2008 is the price of gasoline. The average price of gasoline in 2006 was $3.17/gallon. During the summer of 2008, gasoline prices spiked to an average of $4.28/gallon and then dropped in the fall of 2008 to under $3.00/gallon (EAI 2009). This increased the out-of pocket travel costs (OPTC). OPTC includes the cost of fuel, maintenance and depreciation. The average OPTC in Southern California during the summer of 2006 was approximately $3.40/gallon (AAA 2008). Average OPTC during the summer of 2008 peaked at $4.58 in July and then dropped to $4.00 by September 2008 (AAA 2008). The inflation adjusted 2008 OPTCs are $4.29 ($2006) and $3.75 ($2006), respectively. This is between $0.35 and $0.89 higher than the OPTC prices incurred in 2006.

Higher gas prices could have several effects on visitors to Trestles, including shifting the demographics, the origin of visitors and the attendance. Higher gas prices will create higher travel costs for all visitors so they are likely to visit less often. Visitors with high travel costs may not visit at all. Visitors with lower incomes may visit less often because they are disproportionately impacted by gasoline prices. The percentage of local visitors who have lower travel costs could increase, affecting the average annual avidity. These changes may be revealed in consumer surplus values because avidity is the dependent variable. These hypothesized changes are compared by year and by mode.

Results

Tables 3.2 and 3.3 show the comparison of demographic, recreation and economic variables by survey year for two Internet-based surveys and Tables 3.4 and 3.5 compare the same variables by survey mode using the 2006 Internet-based and the 2008 intercept survey data. Comparison by year and by mode show variation attributed to changes over time, changes associated with higher gas prices during the summer of 2008 and the effect of survey mode.

Effect of different survey years

Demographics by year

All demographic variables are similar across years for the Internet-based surveys with the exception of high income. As shown in Table 3.2, the mean age, highest level of educational attainment, job status and gender are not significantly different between 2006 and 2008. High income is significantly different between year (χ^2= 22.70). In the 2006 Internet-based survey, 41% of the respondents were characterized as earning a high income. In the 2008 Internet-based survey, 70% were characterized as earning a high income. This disparity is discussed below.

Recreational and economic variables by year

Shown in Table 3.3, two recreational use variables were compared by survey year. Years of surfing experience and avidity was not significantly different by year for the two Internet-based surveys.

Average expenditure (per person per visit), average travel distance (round trip miles) and average consumer surplus are compared by year (Table 3.3). Reported average expenditure did not differ significantly by year. Average round trip distance traveled did vary significantly by year. Average round trip distance traveled by the 2006 Internet-based survey respondents was higher (74.1 miles) than respondents to the 2008 Internet-based survey (55.6 miles). Travel cost (out of pocket cost plus time cost) is not significantly different between survey years.

Consumer surplus by year

Consumer surplus is not compared by year because the consumer surplus regression for the 2008 Internet-based survey data was not valid. For these data, there was not a statistically significant relationship between visitation and travel cost ($P = 0.319$), which is a fundamental assumption of the travel cost model (Parsons 2003). This may be due to the low number of observations in the data set ($N=60$).

Effect of survey mode

Demographics by mode

As shown in Table 3.4, there is a significant difference for all demographic variables between survey modes (Internet and intercept) except gender. Mean age is significantly different between survey modes. The intercept survey respondents are younger (average age 32.6 years) than Internet-based survey respondents (average age 35.6 years). Educational attainment between survey modes is significantly different. A higher number of Internet-based respondents report having a college degree or additional education (66%) than intercept respondents (49%). More respondents from the intercept survey were either high school graduates or have not completed college (51%) compared to Internet-based respondents (34%). Job status between survey mode is significantly different. More respondents from the intercept survey report being students (18 %) compared to the Internet-based survey (13%). The intercept survey has more unemployed respondents (4.47) than the Internet-based surveys (2.63%). High income is also significantly different between survey mode at P=0.05 but is not significantly different at P=0.01. Gender was not significantly different between survey mode. Surveys respondents were predominantly male regardless of mode (2008 Internet-based survey: 95%, 2008 Intercept survey: 88%).

Recreational and economic variables by mode

As shown in Table 3.5, experience and avidity were compared by survey mode and both were found to be significantly different. Internet-based respondents reported an average of 19.8 years of surfing experience compared with 16.6 years of experience for intercept respondents. Internet-based respondents averaged 109 visits per year and the intercept respondents averaged 80 visits per year.

Average expenditure (per person per visit), average travel distance (round trip miles) and average consumer surplus are compared by survey mode (See Table 3.5) with mixed results. Average expenditure reported by mode was significantly different. Intercept survey respondents reported higher spending ($65) than respondents to the 2006 Internet-based survey ($40). Distance traveled between survey modes is significantly different: average round trip distance traveled by the 2006 Internet-based survey (74.1 miles) and the 2008 intercept survey (52.7 miles). Travel cost (OPTC plus time cost) is not significantly different between survey modes.

Consumer surplus by mode

The consumer surplus (per person per visit) for the 2006 Internet survey respondents is $138 (95% confidence intervals: $105 -$197). Consumer surplus (per person per visit) for the 2008 intercept survey respondents is $79 (95% confidence intervals $59 -$115).

Discussion

The Internet-based survey responses did not vary by year (2006 and 2008), with two exceptions (See Table 3.6). High income and average distance traveled to the site varied significantly between 2006 and 2008. More of the 2008 respondents reported high income (70%) than those from 2006 (41%). The variation in high income is consistent with what would be predicted given higher gas prices but that might not explain the large discrepancy. Given that the average travel distance was also lower in the 2008 Internet-based survey, it would be reasonable to expect that higher travel costs would disproportionately affect lower income visitors and result in a higher percentage of high-income visitors in the survey. Increased travel cost cannot explain the variation in high income because the average distance traveled is not significantly different for high income and lower income visitors. High-income visitor's average round trip distance is 55.3 miles and non high-income visitors averaged 55.7 miles.

Average travel distance was significantly lower by mode but average travel cost was not significantly different. Average round trip travel distance in 2008 was 55.6 miles and in 74.1 miles in 2006. This suggests that visitors from farther away were less likely to visit in 2008. It is notable that avidity did not significantly vary by year for Internet-based respondents. Visitors from farther away tend to visit less, so higher gas prices may have little effect on the average avidity. The consistent responses for the Internet-based survey between 2006 and 2008 show that Internet-based surveys can return consistent results over time.

In contrast to (Fleming and Bowden 2007) and (Marta-Pedroso, Freitas et al. 2007), in this study survey mode shows a sample that is significantly different across most variables measured (See Tables 3.6). The Internet-based survey shows differences in all demographic variables by mode except gender. Male visitors dominated the gender category in all surveys. The high-income variable differed significantly by year and by mode.

Intercept respondents were younger, had attained a lower level of education and were more likely to be students or unemployed, yet paradoxically yielded a higher percentage of high-income responses. This may be explained by the creation of the high-income variable. The intercept survey instrument asked for household income and the Internet-based survey asked for personal income. The high-income variable was created to make categorical differences comparable.

For the recreational variables, intercept respondents report less experience and lower avidity. The lack of variation in avidity by year for Internet-based respondents suggests that the difference in avidity by mode is a function of the survey mode and not high gasoline prices. It is also unexpected that intercept respondents reported higher daily expenditures than Internet-based respondents, given that their education and economic levels tend to be lower. The higher expenses could be partially explained by higher spending on gasoline.

Average travel distance varied by survey mode and by survey year. Averaged distance traveled dropped for both Internet and Intercept respondents in 2008, but average travel cost did not vary significantly by mode or by year. This suggests that higher gas prices in 2008 reduced the number of distant visitors and the effect was not a result of survey year or mode. This difference could affect consumer surplus values.

Survey mode affected average consumer surplus values. Average consumer surplus was higher for the 2006 Internet-based survey respondents ($138) compared to the intercept survey respondents ($79) but was just within the 95% confidence intervals ($105 -$200 and $59-$115, respectively). In contrast, (Fleming and Bowden 2007) and (Marta-Pedroso, Freitas et al. 2007) found that the Internet-based respondents had a lower willingness to pay (consumer surplus). Consumer surplus is the difference between total area under the supply curve and travel cost (Figure 1.4), so one would expect consumer surplus to decrease as gas prices increase. Demographic variable and level of experience can also shift the demand curve, making it difficult to determine if the lower consumer surplus found from the intercept survey data was a result of higher gas prices or survey mode.

Conclusions and Recommendations

Internet surveys show promise as a low cost, easy to execute survey mode that can quickly reach large numbers of respondents and can reach user groups that can otherwise be difficult to survey (Berrens, Bohara et al. 2003; Fleming and

Bowden 2007; Marta-Pedroso, Freitas et al. 2007). In many cases, use of an Internet-based survey may be the only possibility, the alternative being no survey at all. Internet surveys pose a number of challenges because their error properties are not well understood (Couper 2000). As a result, care must be taken when applying this mode. Intercept surveys, the most common approach for beach studies, is only quasi-random and suffers from endogeneity as a result (Parsons 2003). As stated in (Berrens, Bohara et al. 2003), all survey modes have error. The important consideration is how that error is handled.

> All survey methods involved errors. The appropriate question is not: Can the Internet replace the telephone as the primary mode of administration in social science survey research? Rather it is: Under what circumstances is the use of Internet surveys appropriate? (Berrens, Bohara et al. 2003)

To date, Fleming and Bowden (2007) is the only other paper published that explicitly compares survey Internet-based mode on a revealed preference travel cost study. This study adds to our understanding of the use of Internet-based survey instruments for economic valuation using a revealed preference travel cost study. Using surfing at Trestles Beach as a case study, three surveys are compared for differences in demographics, origin of visitors, expenditures and consumer surplus values. It is shown here that survey mode does have an effect on demographic, recreational and economic variables. Expenditures were found to be higher from intercept respondents. Consumer surplus was lower for intercept respondents. Additional research on weighting by survey will help refine our ability to reconcile bias introduced by survey mode.

This study adds to the small but growing literature on the effect of survey mode on revealed preference travel cost studies and improves our understanding of the advantages and disadvantages of Internet-based survey instruments.

Study	Age	Income	Education	WTP
Berrens et al. 2003[a]	Same	Lower	Lower	Lower
Marta-Pedroso 2007[b]	Lower	Higher	Higher	Lower
Fleming and Bowden 2007[c]	Same	Higher	Same	Same

a) random digit dialing and panel data b) in person c)mail survey

Table 3.1 Demographics comparing Internet survey mode to other modes

Variable	**2006 Internet** (N=971)	**2008 Internet** (N=75)	***t*-test**	**df**
Age	35.6 (11.0)	37.6 (12.9)	1.361**	∞
			Chi-squared	**df**
Education (%)			5.216**	4
Highschool	5	5		
Some college	29	33		
College graduate	39	26		
Some grad school	10	12		
Graduate school	17	24		
Job Status (%)			2.470**	4
Student	13	11		
Part time	8	9		
Full time	76	74		
Unemployed	1	3		
Retired	3	4		
High Income (%)	41	70	22.70	1
Gender			1.101**	1
% male	92	88		

**Significant at P=0.05

Table 3.2 Internet-based survey demographic variables compared by year (2006-2008)

Variable	2006 Internet (N=971)	2008 Internet (N=75)	t-test	df
Experience (years)	19.7 (11.8)	21.8 (12.3)	1.457**	∞
Avidity (annual visits)	109 (102)	111 (105)	0.1845**	∞
Expenditure (average per visit)	$39.96 (69.43)	$50.41 (70.14)	1.225**	∞
Travel Distance (ave. round trip-miles)	74.1 (54.4)	55.6 (45.1)	2.865	∞
Average Travel Cost (ave. round trip cost)	$42.9 (29.7)	$45.90 (36.7)	0.4395**	∞
Consumer Surplus (per person per visit)	$138	--	--	--

**Significant at P=0.05

Table 3.3: Internet-based survey recreational and economic variables compared by year (2006 - 2008)

Variable	2006 Internet (N=971)	2008 Intercept (N=313)	t-test	df
Age	35.6 (11.0)	32.6 (11.0)	3.67	∞
			Chi-squared	**df**
Education (%)			47.72	4
Highschool	5	16		
Some college	29	35		
College graduate	39	30		
Some grad school	10	5		
Graduate school	17	14		
Job Status (%)			26.76	4
Student	13	18		
Part time	8	10		
Full time	76	66		
Unemployed	1	4		
Retired	3	1		
High Income (%)	41	49	6.27*	1
Gender			3.008	1
% male	92	95		

*Significant at P=0.01

Table 3.4 Demographic variables compared by mode (2006 - 2008)

Variable	**2006 Internet** (N=971)	**2008 Intercept** (N=313)	**t-test**	**df**
Experience (years)	19.7 (11.8)	16.6 (11.8)	4.034	∞
Avidity (annual visits)	109 (102)	80.2 (87.9)	4.774	∞
Expenditure (average per visit)	$39.96 (69.43)	$65.35 (95.48)	5.100	∞
Distance travelled (ave. round trip-miles)	74.1 (54.4)	52.7 (41.3)	6.391	∞
Average Travel Cost (ave. round trip)	$42.9 (29.7)	$44.6 (33.0)	0.7297**	∞
Consumer Surplus	$138	$79	--	--

**Significant at P=0.05

Table 3.5 Recreational and economic variables compared by mode (2006-2008)

Variable	Year (2006 & 2008 Internet-based survey)	Mode (Intercept & Internet-based)
Demographic:		
Age	No	Yes
Education	No	Yes
Job Status	No	Yes
High Income	**Yes**	Yes*
Gender	No	**No**
Recreational		
Experience	No	Yes
Avidity	No	Yes
Economic		
Expenditure	No	Yes
Distance Travelled	**Yes**	Yes
Travel Cost	No	**No**
Consumer Surplus	--	Yes

*Not Significant at P=0.01

Table 3.6 Summary of demographic, recreational and economic variable differences by year and mode

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Chapter 4

Mitigating the adverse impacts of shoreline armoring on California beaches

Introduction

California's coastline is being armored in response to coastal erosion, and the California Coastal Commission is struggling to determine the value of beach loss to mitigate for adverse effects from the construction of shoreline protective devices. The California Coastal Commission requires in-lieu mitigation for loss of sand and beach recreation due to passive erosion from sea walls. At present the Coastal Commission approaches each mitigation effort using different values, methods and models. Consistent and more accurate methods to estimate the total economic value of lost beach ecosystem services from shoreline armoring impacts are needed to determine appropriate in-lieu mitigation fees and to ensure the public is being properly compensated for lost recreation and beach ecosystems services.

Approximately ten percent of the California coastline has been armored with seawalls, revetments and wood during the last 100 years (Griggs 2005). Armoring is more concentrated in Southern California's urban counties. Thirty percent of San Diego, Orange, Los Angeles and Ventura County beaches are armored (Griggs 2005). The extent of coastal armoring in California has increased by over four hundred percent during the period from 1971 to 1992 and continues today (Griggs 2005). Shoreline armoring narrows and ultimately eliminates sandy beaches on eroding shorelines through a process called passive erosion (Griggs 2005). In California, approximately 86% of the coast is eroding (Griggs 1998). Accelerating sea level will increase the impacts of coastal erosion (Heberger, Cooley et al. 2009).

Sandy beaches are important natural resources that provide ecosystem services. Ecosystem services include both ecological functions and human services. Human services include coastal recreation, beach access and protection from storms (disturbance protection). Ecological services include habitat, nesting sites and food sources for numerous aquatic and terrestrial species (Defeo, McLachlan et al. 2009).

Despite requirements in the California Coastal Act (CCA) to avoid shoreline armoring for coastal development, existing property owners have a right to protect their property if threatened by erosion (Cardiff 2001, CCA §30253). In these cases, the Coastal Commission is required to "eliminate or mitigate adverse impacts on local shoreline sand supply" (CCA §30253). Adverse impacts include impacts to both ecological and human services provided by beaches.

The Coastal Commission has applied different methodologies for each project to determine the value of lost recreational use and has not considered ecosystem service-based approaches to value or restore impacted beaches. As a result, mitigation fees are often subject to litigation, values for lost recreation may be improperly valued and other ecosystem services values have not been consistently considered.

The objective of this chapter is to provide conceptual models for supply-based service-for-service and demand-based approaches for mitigating for adverse impacts on local shoreline sand supply, discuss their strengths and limitations, review the use of non-market values to estimate lost coastal recreation, show through comparative analysis of past projects (case studies) the degree to which Coastal Commission approaches have accurately captured the value of lost beaches and provide recommendations for a consistent and more accurate approach based on accepted practices in the literature.

A conceptual model for an ecosystem-based approach to mitigation for loss of sand supply is provided. This model includes an explicit set of ecosystem services provided by sandy beaches. The federal Natural Resource Damage Assessment (NRDA) Habitat Equivalency Analysis (HEA) approach is discussed as an alternative. Limited research on beach ecosystem functions and their economic values prohibits valuation of these services but provides a conceptual model to show what values are not included. The models show that mitigation based on recreation and sand impoundment alone underestimates the adverse impacts of erosion. Two demand-based models are described and the amenity-based model shows potential as a practical approach for use by the Coastal Commission. A comparative analysis compares this approach to past practices that have resulted both in overestimates and underestimates in valuing lost recreation from adverse impacts of shoreline protective devices.

The California Coastal Act

The California Coastal Act (CCA) was written to ensure balanced utilization of coastal zone resources taking into account the social and economic needs of the people of the state and to maximize public access and recreational opportunities (CCA, §30001.5). Numerous sections of the CCA specifically require protecting and maximizing coastal access and recreation along the coastal zone (See Sections 30210, 30211, 30212(a), 30213, 30221). The CCA further specifies that coastal areas suited for water-oriented activities that cannot be substituted inland shall be protected (CCA, §30220). When the CCA allows protection of coastal development that will impact beach access and recreation, the CCA requires that the impacts be mitigated.

Section 30235 of the CCA guides Coastal Commission decisions for permitting shoreline armoring to protect structures along the coast that are threatened by coastal erosion. Section 30235 of the California Coastal Act states:

> Revetments, breakwaters, groins, harbor channels, seawalls, cliff retaining walls, and other such construction that alters natural shoreline processes **shall** be permitted when required to serve coastal-dependent uses or to protect existing structures or public beaches in danger from erosion **and when designed to eliminate or mitigate adverse impacts on local shoreline sand supply**. Existing marine structures causing water stagnation contributing to pollution problems and fishkills should be phased out or upgraded where feasible. (CCA, §30235, emphasis added)

Recent law journal articles have concluded that the California Coastal Act compels the Coastal Commission to make permitting decisions that are "in a manner which on balance is the most protective of significant coastal resources" and therefore should avoid shoreline armoring if at all possible (Cardiff 2001; Caldwell and Segall 2007). Caldwell and Segall (2007) find that in some cases it will be necessary for the Coastal Commission to permit shoreline armoring that will be destructive to public resources, public access and coastal recreation.

The Coastal Commission's requirement for compensatory mitigation for the impacts of shoreline armoring has evolved over time. Since 1993, the Coastal Commission has required an in-lieu fee to mitigate for sand loss due to impoundment loss. Impoundment loss is sand trapped behind the structure. A procedural guidance document was created by the Coastal Commission in 1997 to provide a standard approach to calculating this fee (CCC 1997). Since 2004, the Coastal Commission has required an in-lieu fee to mitigate for lost recreational opportunity from beach loss due to passive erosion. The Coastal Commission has not used a consistent approach to calculate this fee. In some cases the Coastal Commission has acknowledged that their approach is conservative because the mitigation fee does not capture all values lost from a narrowing beach. For example, ecological services provided by beach habitats are not valued and included in the fee.

The impact of shoreline armoring on beaches and coastal recreation

Shoreline armoring structures protect coastal development by preventing naturally occurring beach and bluff erosion (Griggs 2005). Shoreline armoring structures are typically concrete walls or rock revetments designed to prevent wave action from eroding the shoreline (Figure 4.1). Shoreline armoring has several impacts that limit sand supply and reduce the width of the beach. First, beach area under the footprint of the actual armoring structure is lost. This is known as placement loss. For example, riprap revetments can occupy over 30 feet of beach width for their entire length. Second, beach sand that would have eroded from the beach or bluff is impounded behind the structure and is not available to the beach. This is known as impoundment loss. Third, beach is lost due to passive erosion (Figure 4.2). Passive erosion occurs because the back of the beach, that would otherwise naturally migrate landward, is fixed (Griggs 1985). As relative sea level rises the beach is submerged and the beach will gradually narrow until the public beach no longer exists.

Armoring the beach will ultimately result in the total loss of public beach seaward of the structure, limit beach access and deny other forms of coastal recreation in the area influenced by the shoreline armoring (Cardiff 2001; Caldwell and Segall 2007). For example, loss of the beach will reduce lateral access along the beach and can limit access to other beach areas or recreational sites. Loss of the beach can also cause wave reflection off the seawall or revetment that can degrade the quality of a surfing area or make it unsafe for swimmers to enter the water.

Shoreline armoring and the resultant beach loss will reduce and eliminate intertidal and supratidal[1] sandy beach habitat. Sandy beaches are important habitats that provide food sources, nesting sites and rookeries for a broad range of species. (Dugan, Hubbard et al. 2000; Dugan, Hubbard et al. 2003; Hubbard and Dugan 2003). Dugan and Hubbard (2006) and Dugan, Hubbard et al. (2008) show that shoreline armoring has a negative effect on sandy beach habitat as the beach narrows by eliminating supratidal habitats and compressing intertidal habitats resulting in lower abundance, biomass and size of macroinvertebrate species. Loss of the macroinvertebrate species (e.g. beach hoppers) that are an important food source for birds, and reduces the species richness and abundance of shorebirds and Gulls (Dugan, Hubbard et al. 2008).

The adverse impacts of shoreline armoring on public recreation and beach ecosystems are a loss of public resources. Mitigation must accurately estimate the lost value of recreation and ecosystem functions to compensate the public for lost resources. Over 100 miles of the California coastline have been armored, and less than 0.2 miles have included mitigation for lost recreation and no mitigation has been required for loss of ecological functions.

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[1] Supratidal is the zone of the beach immediately marginal to and above the high-tide level.

The Coastal Commission's definition of mitigation

The California Coastal Act does not contain a definition of mitigation. The Coastal Commission uses the California Environmental Quality Act (CEQA) definition of mitigation (CCC 1997). Mitigation as defined by the California Environmental Quality Act (CEQA) Section 15370 includes measures that will eliminate, avoid, rectify, compensate for or reduce environmental effects when an environmental impact or potential impact is identified (CEQA 2009). Mitigation is the proactive avoidance or compensation for anticipated impacts from a project. Compensation is used to replace or provide substitute resources or environments when a direct impact is avoidable and the resources cannot be mitigated on site. The CEQA definition of mitigation provides a hierarchical series of alternatives based on impact avoidance that should be considered in sequence (Figure 4.3). The sequencing approach to mitigation is based on a Memorandum of Agreement between the Environmental Protection Agency and the Department of the Army concerning the determination of mitigation under the Clean Water Act Section 404(b)(1) guidelines (MOA 1990).

The Coastal Commission applies this approach to mitigation through an alternatives analysis for each permit request for shoreline armoring. The Coastal Commission prefers to recommend mitigation that avoids, minimizes, rectifies or reduces impacts from shoreline armoring, but there are cases where it is impossible to avoid all impacts and therefore require compensatory mitigation for adverse impacts on local shoreline sand supply.

Prior to 1993, the Coastal Commission did not require compensatory mitigation for the adverse impacts to sand supply from the construction of shoreline protective devices. Between 1993 and the present, they began assessing an in-lieu fee for beach sand impounded behind the shoreline protective device. Starting in 2004 the Coastal Commission began assessing an in-lieu fee to mitigate for lost beach recreation due to passive erosion. The Coastal Commission (2005) and Caldwell and Segall (2007), acknowledge that this represents an incomplete model for assessment of the full adverse impacts to human and ecological services provided by the beach habitat.

Mitigating lost beach ecosystem services

Current decision making processes, including the Coastal Commission approach to mitigating the adverse impacts of shoreline armoring, often ignore or underestimate the value of ecosystem services (MA 2005).

> Failure to quantify ecosystem values in commensurate terms with opportunity costs often results in an implicit value of zero being placed on ecosystem services. In most cases, ecosystem services have values larger than zero (Loomis, Paula et al. 2000).

Implementation of an ecosystem services approach could account for the full range of services provided by sandy beaches. These services include recreation and ecological services such as nutrient cycling (Table 4.1).

The Millennium Ecosystem Assessment (MA) report and the NRC report on Valuing Ecosystem Services provide an ecosystem service model to account for the human and ecological services provided by beaches (NRC 2004; UNEP 2006). The Total Economic Value (TEV) approach, recommended by the MA, provides a model to account for the full range of economic values associated with ecosystem services. The Natural Resources Damage Assessment (NRDA) provides a service-for-service approach for restoration of lost ecosystem services. Use of these models can provide a more complete accounting for the services of beaches and how to value those impacts for compensatory mitigation.

The total economic value (TEV) model provides a framework for valuing ecosystem services, including sandy beaches. The TEV framework is based on the presumption that individuals have multiple values for ecosystems and provide a framework to ensure that components of that value are not missed or double counted (NRC 2004). The TEV framework separates ecosystem services into direct and indirect use values and considers non-use values (Figure 4.4). The sandy beach ecosystem services described by Defeo, McLachlan et al. (2009) are all either direct or indirect use values (Table 4.1). Direct use values can be measured using revealed and stated preference approaches (described in Chapter 1). Indirect uses are more challenging to measure and often require models that link direct use commodities with ecosystem services (NRC 2004). Production function approaches seek to determine how changes in ecosystem services affect an economic activity, then measure the impact of the change on economic activity (NRC 2004). For example, loss of sandy beach prey resources to lower biodiversity of shore birds could be linked to lost consumer surplus of bird watchers.

Option and bequest values describe the value of preserving the option for use of services in the future either by an individual (option value) or by future generations (bequest values). The primary non-use value is existence value. Existence value is unrelated to the use of the resource and represents the willingness to pay for the resource to exist (e.g., willingness to pay for the protection of a beach you will never visit). Non-use valuation requires contingent valuation methods.

Ecosystem services

Efforts to define and value ecosystem services go back several decades (Liu, Costanza et al. 2010). Ecosystem services are the benefits people obtain from ecosystems. The full definition of ecosystem services provided by the United Nations Millennium Ecosystem Assessment (MA) is:

> Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other nonmaterial benefits (MA 2005).

The ecosystem services model is anthropocentric by definition, but the MA makes clear that sound ecosystem management must include the intrinsic values of ecosystems. Intrinsic values cannot be given a monetary value and instead require a values-based decision making structure (MA 2005).

Coastal ecosystems are among the most productive and heavily used ecosystems in the world and provide many services to human society (UNEP 2006). Sandy beaches are one of the largest marine biomes on the planet (Etnoyer, Wood et al. 2010). Sandy beach ecosystems are one of the most heavily used but poorly understood coastal ecosystems, and our understanding of their ecological functions is limited (Defeo, McLachlan et al. 2009). Defeo, McLachlan et al. (2009) describe the ecosystem services provided by beaches (Table 4.1).

Together, the ecosystem services model and the TEV model provide a framework to account for a more complete set of ecosystem services provided for by sandy beaches. Option values and non-use values pose a difficult challenge to determine quantitative dollar values, but their values are greater than zero (MA 2005).

Coastal Commission's mitigation approach

In cases where the Coastal Commission has no choice but to permit shoreline armoring (Step 5 in the mitigation hierarchy in Figure 4.3), impoundment loss, placement loss and passive erosion will narrow the beach and cause a loss of the flow of recreational and ecological services provided by the sandy beach. The Coastal Commission is faced with a choice of how best to compensate for the impact by either replacing or providing substitute resources or environments. At present, the Coastal Commission uses a demand-based approach to compensate for lost beach services. This approach uses non-market valuation to determine the lost value of beach recreation resulting from the loss of beach but has yet to account for loss of ecological services. An alternative is a supply-based approach, using the Natural Resource Damage Assessment's Habitat Equivalency Analysis (HEA), which could provide a more robust model that accounts for lost beach recreation and also lost ecological services. This approach inherently accounts for the total economic value of the beach by seeking to restore all the use and nonuse values provided by the sandy beach.

Demand-based approach: non-market valuation

Non-market valuation is a demand-based approach that can be used to determine compensation for loss of beach services. The value of use and non-use values for beach services are expressed in terms of consumer surplus. Consumer surplus is a measure of the economic benefit to the individual – the difference between the maximum willingness to pay and the price actually paid for the good (See Chapter 1). This approach is well studied for beach recreation but is limited when applied to non-use values (Figure 4.4) and ecological services. This is the approach currently used by the Coastal Commission to value lost beach recreation. To capture the full set of ecological services provided by sandy beaches, the non-market valuation approach requires determining consumer surplus values for lost recreation and ecological services.

Estimating the baseline recreational value of a beach

The annual recreational value (or total consumer surplus) of a beach is determined by summing all of the individual consumer surplus values of beach visitors. This can be calculated by multiplying the average individual consumer surplus (per person per visit) by the annual attendance at the beach area.

$$CS_{beach} = CS_{ave} * attendance$$

Equation 4.1: Consumer surplus value of a beach.

where CS_{beach} is the total annual consumer surplus. CS_{ave} is the average individual consumer surplus per visit and *attendance* is the annual attendance of the beach area. The average individual consumer surplus (per visit) can be determined by site-specific original non-market valuation approaches such as Random Utility Models (discussed below), travel cost methods, and contingent methods or approximations derived from original research conducted elsewhere (i.e. benefit transfer method) (See Chapter 1). Annual attendance is based on counts of beach visitors. See King and McGregor (2010) for a discussion on attendance counts at California beaches.

Using benefits transfer to determine the consumer surplus of a beach visit

It is recognized that site-specific studies are more accurate to determine non-market values, however site specific studies are expensive and time consuming (Pendleton, Atiyah et al. 2007). For example, if the cost of the site specific study by City of Solana Beach study ($100,000) for 1.4 miles of sandy beach was applied to the 668 miles of sandy beach in California, it would cost over $47 million to develop site specific studies for all beaches in the state. One alternative is to "transfer" the benefit estimates from existing studies (study site) to the site being considered (policy site). The transfer of value estimates from the study site to the policy site range from complex analysis that adjusts the consumer surplus based on a comparison of the individual attributes of each site called a function transfer (e.g. meta-analysis transfer) to simply applying a single value from a related study site to the policy site (point transfer). See Atiyah (2009) for a review of benefit transfer applications in coastal management. If relevant studies exist, a range of values can be considered or averaged. The weighted amenity approach (discussed below) provides a middle ground that adjusts the consumer surplus based on a weighted set of beach amenities, including weather, water quality, beach width and quality, overcrowding, additional amenities and substitution. All benefit transfer methods are limited by the quality of the original study and the transferability of the conditions from the study site to the policy site (Desvouges, Johnson et al. 1998).

Valuing lost recreation on an eroding beach

Determining the value of lost beach recreation that occurs because of shoreline armoring is more complicated. It requires determining lost recreational value of the beach area seaward of the shoreline armoring structure as the beach narrows over time. It should also include adjacent beach impacts, down coast impacts and loss of access to adjacent beaches. The primary characteristic of beach change over time is beach width. Beach width is an amenity that limits the area of the beach available to users and can affect the consumer surplus of a beach visit directly by changing the area of beach available to recreate.

Reduction in width can also affect the level of crowding at a beach, which also may affect consumer surplus (although this last affect is complicated by the fact that lower per person per visit consumer surplus also lowers attendance at the affected beach). A portion of the beach width is lost immediately from placement loss when the shoreline protective device is constructed. Over time, the change in beach width is controlled by the erosion rate at the beach. Lost beach width can reduce the individual consumer surplus or can result in substitution, if the visitor chooses to visit a different beach. (King 2001; Lew and Larson 2005; Pendleton, Mohn et al. 2011). The time over which the lost value is estimated is determined by the lifetime of the project, which is set by the Coastal Commission upon permitting the shoreline protective device.

Changes in the recreational value of a beach are determined by summing the lost individual consumer surplus per visit due to lost beach width for each visit over the lifetime of the project adjusted to the net present value.

$$CS_l = \sum_{t=0}^{n} \frac{(\Delta CS_i\ (\boldsymbol{bw_t}) * attendance_t)}{(1+r)^t}$$

Equation 4.2 Consumer surplus lost on an eroding beach.

Where CS_l is the net present value of lost consumer surplus over the lifetime of the project. n is the project lifetime in years. ΔCS_i is the loss of consumer surplus as a function of beach width (bw_t) on year t. bw_t is a function of placement loss at $t=0$ and the erosion rate from *t=1* to *t=n*. *attendance* is the annual number of beach visits for year *t*. *r* is the discount rate.

<u>Random utility model</u>

The most sophisticated methods to account for lost recreational value over time use a Random Utility Model (See Chapter 1). These methods model site choice based on beach characteristics and the cost of visiting the beach. A RUM models beach choice by including all beaches that the beach goer might consider as reasonable choices (and sometimes includes non-beach options too). Using a RUM the value of beach visits is revealed through the choice of which beach to visit, based on beach characteristics and the cost of visiting the beach. The RUM requires survey data for multiple beaches and complex economic modeling. RUM studies are time consuming, costly and impractical for coastal planners.

<u>Area-based model</u>

A simpler method, previously used by the Coastal Commission, is the area-based model. The area-based model estimates the annual value of each unit area of beach based on the consumer surplus per visit, the total number of visitors and the total area of this beach. In this method, the individual consumer surplus (per visit) is determined using a benefits transfer approach.

$$CS_{area} = \frac{CS_{bt} * attendance}{area}$$

Equation 4.3 Area-based Consumer surplus.

Where CS_{area} is the annual consumer surplus per unit area. CS_{bt} is the individual consumer surplus (per visit) based on the benefits transfer. *attendance* is the annual attendance at the beach and *area* is the area of the beach that is between the shoreline protective device and the ocean. Lost consumer surplus is then estimated by summing the annual value of lost beach due to erosion over the lifetime of the project and adjusted to the net present value.

$$CS_{total} = \sum_{t=0}^{n} \frac{(CS_{area} * er * t)}{(1+r)^t}$$

Equation 4.4 Area-based method to determine consumer surplus lost on an eroding beach.

Where CS_{total} is the total consumer surplus lost during the lifetime of the project. n is the project lifetime in years. er is the annual erosion rate, t is time (the number of years since project started) and r is the discount rate. In the area-based model individual consumer surplus value does not change as the beach narrows. The limitations of this method are described below.

Amenity-based model

Developed by King (2005; 2006), the amenity-based model is used both as a benefit transfer method and to adjust the individual consumer surplus (per visit) as the beach narrows. As a benefit transfer method, the amenity-base approach adjusts the consumer surplus of a study site by weighting and rating the amenities at the policy site compared to a base case study site.

The beach amenities considered are: weather, water quality, beach width and quality, overcrowding, other recreational amenities and availability of substitutes. Based on the Cobb-Douglass functional form, each amenity is given a weight and amenity point value from 0 to 1, as described in Equation 4.5

$$IV = W^a * WQ^b * BWQ^c * C^d * A^e * S^f \quad \text{where: } a+b+c+d+e+f=1$$

Equation 4.5 Index Value (*IV*) based on weighted amenities.

Where *IV* is the total index value, *W, WQ, BWQ, C, A* and *S* are amenity index point values. *a* through *f* are the relative weightings. See example in Table 4.2.

The weighted amenity value is then used to adjust the consumer surplus from the study to the policy site. The amenity values and weights were assigned using general criteria described in King (2006) and builds on US Corps of Engineers' point values used to estimate the value of a recreational day. In practice, the values and weights have been based on personal judgment and have not been empirically based. The index value (*IV*) is then used to adjust the consumer surplus value at the policy site (CS_p) from the consumer surplus value at the study site (CS_s).

$$CS_p = CS_s * IV$$

Equation 4.6: Using the Index Value (*IV*) to adjust the consumer surplus at the policy site (CS_p).

Where CS_p is the consumer surplus at the policy site and CS_s is the consumer surplus at the study site and *IV* is the index value from the weighted amenities (Equation 4.5).

Weighted beach amenities are also used to determine the decrease in consumer surplus value from t=0 and over time project lifetime (t=n) as the beach width decreases. As beach width decreases, the amenity point values for beach width (*BWQ*) and overcrowding (*C*) decrease proportional to percentage of total beach width (B_n). The total lost consumer surplus is from lost amenity value to each visitor due to the narrowing beach over the lifetime of the project.

$$CS_{SL} = \sum_{t=0}^{n} \frac{CS_P - (CS_p * IV_t) * att}{(1+r)^t}$$

where

$$IV_t = W^a * WQ^b * (B_t * BWQ^c) * (B_t * C^d) * A^e * S^f \text{ where: } a+b+c+d+e+f=1$$
$$\text{and } B_t = \frac{bw_t}{bw_{t=0}}$$

Equation 4.7 Consumer surplus lost over project lifetime due to lost amenity value from beach erosion (King 2006).

Where CS_{SL} is the net present value of the total lost consumer surplus over the project lifetime (t=n), CS_P is the consumer surplus at the policy site, IV_n is the amenity value adjusted for a narrowing beach and B_t is the percentage of beach remaining. r is the discount rate. When $B_t = 0$, the lost consumer surplus of the beach in front of the sea wall (CS_{SL}) is at its maximum for the remaining project lifetime.

Review of the demand-based models

Use of a demand-based approach by the Coastal Commission, as described above, requires an individual consumer surplus value per visit using a benefit transfer approach, annual attendance counts, and a model to account for lost attend loss of consumer surplus from recreation and ecological services as the beach narrows (Table 4.3). The benefit transfer requires an empirically based per-person per-visit consumer surplus value for beach recreation at the study site that is transferred to the policy site and adjusted for time and based on objective, repeatable criteria. It requires an erosion-value loss model that represents a reasonable approximation of the loss of consumer surplus as the beach narrows. Pendleton, Mohn et al. (2011) recently published a RUM based empirical model that describes changes in beach visitation and consumer surplus due to beach narrowing.

Beach recreation consumer surplus values

Estimates of the consumer surplus value for California beach visits appear throughout the literature. Table 4.4 shows a sampling of values for existing site-specific studies for California beaches that can be used as the study site for benefits transfer. The consumer surplus of a beach visit from site-specific studies varies from $12 to $90 vary with a range of over $78. The average value across these studies is $39. Pendleton and Kildow (2006) used a range of $15 to $50 for their overview of the non-market value of beach recreation in California. The consumer surplus of a beach visit is a critical parameter in the valuation of the total value provided by the beach and is the basis benefit transfer from a study site to the policy site. It is also the basis for determining the lost recreational value as the beach narrows.

Attendance

The recreational value of a beach is proportional to the attendance. Attendance is the largest multiplier in determining the consumer surplus of a beach. Dwight, Brinks et al. (2007) show that there are attendance counts for most Southern California beaches. Literature on beach attendance for other California beaches is limited. Most attendance records come from beach management agency and lifeguard attendance estimates and often overcount visits (King and McGregor 2010). Wallmo (2003) and King and McGregor (2010) provide methods for site specific studies using periodic counts and sub-sampling to determine the multiplier. The Coastal Commission does not have the time or funding for site specific studies for each project and must rely on available data. Unlike consumer surplus values, it is not possible to transfer attendance counts due to the extremely high variability of beach attendance, which is dependent on the location, season, access and beach width. A complicating factor is that beach attendance is dependent on beach width and shoreline armoring, but our understanding of this relationship is limited and requires complex RUM modeling (Pendleton, Mohn et al. 2011).

Erosion model for loss of recreational value

As described above, the value of lost recreation on an eroding beach is estimated by determining the lost beach area and then determining the lost consumer surplus value from the narrower beach on an annual basis over the lifetime of the project. At present, the only empirical model describing changes in consumer surplus and beach attendance on an eroding beach in California is Pendleton, Mohn et al. (2011). Pendleton, Mohn et al. (2011) describe changes in beach attendance and consumers surplus to Orange and San Diego County beaches in response to sea level rise using a RUM model. They show that beach erosion reduces both consumer surplus and beach visits and that those losses can be significant. For example, at 50% decrease in width of San Clemente beaches results in an annual loss of over $8 million in consumer surplus and over 100,000 fewer beach visits. The direct application of Pendleton, Mohn et al. (2011) to individual shoreline armoring permits is limited but could be used as a study site for benefits transfer and to set the bounds for estimates of consumer surplus loss at armored beaches.

As a practical matter, the Coastal Commission is limited to applying simple models such as the area-based or the amenity-based models. The area-based method applies a constant consumer surplus value as the beach narrows. This model assumes that beach attendance decreases linearly with lost beach area. This model does not account for visitor adjustment to beach narrowing, such as moving closer together (beach crowding) or accepting a lower consumer surplus from a visit on a narrower beach. In contrast, the weighted amenity-based model assumes that the consumer surplus of each visitor decreases slightly each year from the of loss amenities associated with beach width and overcrowding as the beach narrows. In the amenity-based model, the first year of erosion has little effect on the total value of the beach, but as the beach narrows, the loss increases exponentially until it reaches a maximum when the beach width equals zero (Figure 4.5).

The total lost recreational value over the project lifetime is adjusted to the net present value because the in-lieu mitigation fee is charged at the outset of the project, not on an annual basis. The Coastal Commission has consistently used a 3% discount rate, which is standard practice in the literature and recommended by NOAA (NOAA 2000; Dunford, Ginn et al. 2004).

The amenity-based model has advantages over the area-based model but is also limited in theory and application. The amenity-based model can be used to estimate the policy site consumer surplus value and then adjust that value as the beach narrows due to the loss of amenities. The amenity-based model estimates the loss of consumer surplus for each visitor due to loss of beach width and overcrowding through a decline in the amenity values that correspond to percentage of beach lost. In the amenity-based model, visitation does not decline linearly with area of beach lost. The amenity-based model accounts for variation in site characteristics of individual beaches and provides a rudimentary means to account for substitution. The amenity-based model accounts for variation in site characteristics of individual beaches and also provides a rudimentary means to account for substitution.

The primary shortcoming of King's application of the amenity-based method is not a methodological but the subjective assignment of amenity values and weights at the beach. Although King (2006) provides some basis for the relative weights and amenity point values, the values are not based on empirical data nor is there a standard method for determining the weights or the point values. The amenity point values and weights are subjective and vary for each permit application. The RUM used for the Southern California Beach Valuation project could provide an empirical method to determine amenity values but is beyond the scope of this paper.

Another theoretical shortcoming of King's amenity-based model is that it does not account for lost beach attendance as the beach narrows. Instead, it assumes that beach attendance stays constant or grows up to the point where the beach ceases to exist. The method could be improved by accounting for loss in beach attendance based on a minimum area of beach required for each beach visitor. Pendleton, Mohn et al. (2011) show that the amenity-based model may be conservative because it does not account for lost attendance from substitution, which they observed. Inclusion of lost visits would increase the total lost consumer surplus at an eroding beach because one hundred percent of that visitor's consumer surplus would be included the mitigation model.

A loss of beach area may simply cause beach goers to choose (substitute) another beach. Theoretically, a single site approach like that in the Amenities model should over estimate the impact of beach loss because it does not account for the substitution possibilities available to the beach goer. In contrast, use of multi-site RUM models that account for substitution show that consumer surplus values for reduced beach attributes (e.g. beach width) or complete loss of a site will be less than single site approaches such as the amenity-based model (Lew and Larson 2005). In practice, the number of beach substitution possibilities are limited in southern California, even though the total number of beaches is large. Cutter, Pendleton, et al. (2007) show that restrictions in the types of activities and the effect of site attributes on activities limits the substitutability of sites. Further, while travel cost to a large set of beaches may be similar for people coming from inland areas, people who live near the beach face significant increases in travel cost if they cannot go to their local beach. Small beaches with highly local visitors may also limit the actual substitution set. For example, Pendleton, Mohn et al. (2011) show that even in a model that includes 50 potential substitute sites changes in beach width can result in large loss of consumer surplus and visitors (e.g. a 50% loss in beach width at San Clemente Beach would result in an annual consumer surplus loss of $8 million). The current amenity-based model accounts for substitution possibilities through the inclusion of a linear explanatory factor – a coarse and subjective way of accounting for the potential bias caused by substitution possibilities. With additional research to develop empirically based point values and weights, the amenity-based model could provide a practical, objective and transparent model for the Coastal Commission to estimate the loss of consumer surplus of each beach visitor to a narrowing beach. Furthermore, the chapter demonstrates that methodological biases that may cause amenity-based models to overestimate the impact of beach loss on recreation values are likely to be offset by the omission of numerous other beach values (e.g. habitat protection) that are not included in more sophisticated models that include only recreational values.

Ecosystem services in the demand model

At present, there is no research in the literature that quantifies the entire set of ecosystem service values for sandy beaches described in Table 4.1 (Liu, Costanza et al. 2010). Liu, Costanza et al. (2010) provide an ecosystem services value for New Jersey beaches at $42,147 ($2004) per acre. Their ecosystem services value includes an aesthetic and recreational value ($14,847/acre) and a shoreline protection (disturbance control) value ($27,276/acre) but does not include values for other ecosystem services. Aesthetic and recreational consumer surplus values for California beaches are well researched and can be applied more appropriately than the generic model provided by Liu, Costanza et al. (2010). Disturbance control is not relevant for beaches where shoreline protective devices are being constructed because these structures are designed to eliminate any future shoreline disturbance.

At present, the limited understanding of beach ecosystems and the lack of models linking beach ecosystem services to direct use activities precludes assigning a value to ecosystem services outside of recreational opportunities and disturbance avoidance (Liu, Costanza et al. 2010). The total economic value (TEV) of ecosystem services outside of recreational opportunities and disturbance avoidance is greater than zero and shows that valuation efforts that do not include ecosystem services are an underestimate of the total economic value of beach ecosystems. The TEV model reveals the practical need for future research that explains the linkages between impacts to beach ecosystem services and economic values of beaches.

Supply-based approach: Natural Resource Damage Assessment

An alternative approach to the demand-based model for determining the compensatory mitigation for lost ecosystem services is the federal Natural Resource Damage Assessment (NRDA) approach. The federal NRDA process provides a rigorous and well-tested method for assessing and restoring natural resources and services impacted by oil and chemical spills with a rich peer reviewed body of literature (Roach and Wade 2006). While the NRDA process is reactive (responding to the injury of natural resources) and the Coastal Commission's mitigation process is proactive (requiring mitigation for future impacts), the concepts in the NRDA process can provide a model for implementing an ecosystem services approach to mitigating adverse impacts to beaches from shoreline armoring.

Habitat equivalency analysis

In recent NRDA cases, NOAA has recommended that compensation should be based on restoration projects using habitat equivalency analysis (HEA). HEA is a method for quantifying ecological service losses and calculating the scale of compensatory restoration required to offset those losses (Dunford, Ginn et al. 2004). Compensation is based on the cost to replace the natural resource services that the public has lost (Hampton and Zafonte 2002). Scaling is used to account for restoration that does not meet the baseline functionality of the lost resource and to discount for the time between the loss and full restoration, known as interim losses (Figure 4.6).

The four basic requirements needed for an HEA are: 1) the primary services lost are biological, as opposed to human use services, 2) there exists a means of quantifying the level of lost services due to the injury and the level of services gained by the compensatory mitigation, 3) an estimate of the recovery rates is available, and 4) a suitable restoration site exists. Further, HEA requires that a single measure of ecological services be used for each type of habitat assessed in the model (NOAA 2000). This metric is the single most important parameter in the HEA model because it is the basis for all assessment of injury and restoration (Dunford, Ginn et al. 2004). The input parameters required for the HEA model are listed in Table 4.5

Use of HEA requires a number of assumptions. They include a preference for compensation with the same services, use of a single service metric, a fixed proportion of habitat services to habitat value, a constant real value of injured services and an equal unit value for the injured and compensatory habitat values (Dunford, Ginn et al. 2004).

NOAA's (2000) guidance document provides an overview and examples of HEA application. Dunford, Ginn et al. (2004) discuss the conceptual foundation, key assumptions and sensitivity analysis using a hypothetical example. Milon and Dodge (2001) show the application of HEA to coral reef damage assessment and restoration. Roach and Wade (2006) provide an example of HEA applied proactively for policy analysis.

Use of HEA for beach ecosystems services

The use of HEA by the Coastal Commission for compensatory mitigation to adverse impacts to beaches from shoreline armoring would shift their approach from a demand-based model aimed at compensating lost beach recreation to a supply-based model that is focused on restoration of ecological services of beaches. This approach would require that beach dredge and fill (beach nourishment) projects are focused on returning ecological services of beaches to an established baseline as opposed to the current focus on sediment quality and beach width.

At present, use of HEA for compensatory mitigation of lost beach services is limited by a lack of understanding of the ecological services of beaches. Table 4.6 shows that sandy beach ecosystem services do not meet the four basic requirements to conduct HEA. The primary service considered by the Coastal Commission is recreation, a human use, not a biological use. The current lack of basic science on ecological services of beaches precludes selecting or quantifying a single measure of ecological services lost or providing recovery rates from impacts (Martin 2009). Impacts include loss of habitat from the gradual narrowing of beaches or burial from the dredging and dumping of sand on the eroded beach (Peterson and Bishop 2005; Dugan, Hubbard et al. 2008). Suitable sites for restoration of beach services could be the beach being adversely affected or nearby beaches.

The HEA approach is further limited because shoreline protective devices are issued on different temporal and spatial scales than coastal erosion, and beach dredge and fill projects. Shoreline armoring permits are issued at the spatial scale of a single development and episodically, based on threats from erosion. Coastal erosion and beach dredge and fill projects occur on the littoral cell scale and are also episodic. Beach erosion occurs episodically based on decadal weather system, such as ENSO (Griggs 1998). Beach dredge and fill projects are episodic and based on federal, state and local funding cycles and permit requirements. HEA does provide a mechanism to address spatial and temporal mismatches but would be challenged by having numerous small compensatory mitigation actions cumulatively support one larger restoration effort. There are also governance challenges. The Coastal Commission is the agency responsible for permitting and seeking mitigation for adverse impacts of shoreline armoring but other state and federal agencies are responsible for beach dredge and fill projects. Coordination between these agencies would be required for the HEA model to function successfully.

Model choice conclusions

The Coastal Commission is faced with two primary limitations when determining the compensatory mitigation for lost beach services from shoreline armoring. First, the lack of scientific understanding of baseline sandy beach ecological services and the inability to quantify services lost or recovery rates of those services precludes the use of service-for-service (HEA) models for mitigation or the inclusion of ecological services in demand-based models. Second, limitations in permit time lines, budget and expertise on the Coastal Commission staff preclude the application of site specific beach valuation studies or the use of Random Utility Models for demand-based modeling of the loss of beach services values on armored beaches except for large projects. Given these limitations, a demand-based approach using the amenity-based model could provide the best alternative for the Coastal Commission because it provides a transparent and repeatable approach to adjust of consumer surplus values to the study site and model loss on consumer surplus as the beach narrows. To use this model, the Coastal Commission should support some RUM studies of representative beaches, which supplement the Southern California Beach Valuation Study, to develop a set of study sites that can be used to develop amenity weights and values for use in benefit transfers.

The methods currently used by the Coastal Commission can be improved to provide more accurate and consistent compensatory mitigation values. To show this a comparative approach is taken reviewing five case studies where the Coastal Commission has applied demand-based models. The case studies are described and compared against recommended consumer surplus value choices for benefit transfer of beach recreation values, attendance and beach erosion value loss models.

Case studies: mitigation for loss of beach recreation

Since 2004, the Coastal Commission has required compensatory mitigation for the value of lost recreational beach use for five projects. All projects have used a benefits transfer approach. The Coastal Commission has applied both the area-based and the amenity-weighted method. The Coastal Commission is also reviewing a site-specific approach for the City of Solana Beach. Each case study includes a description of the project, the recreational use at the beach (attendance), the method of estimating consumer surplus and lost consumer surplus over time and a total in-lieu fee assessed. Table 4.7 provides a summary of the projects. The Las Brisas and Ocean Harbor House projects are the best representations of the area-based and amenity-based methods and are reviewed in more detail.

Case study 1: Las Brisas, Solana Beach, California

In 2005, the Coastal Commission required mitigation for the adverse impacts of a seawall on beach recreation using the amenity-based model to estimate the consumer surplus value of an individual beach visit and for the erosion value loss model.

Project description

Las Brisas is a 36 condominium complex immediately adjacent to a coastal bluff near Fletcher Cove in Solana Beach, CA. The bluff is eroding due to wave action and threatening the structure. To protect the structure, the homeowners requested a permit from the Coastal Commission to construct a 120-foot long 35-foot high seawall at the base of the bluff on the public beach (Figure 4.7). The long-term average annual erosion rate was determined to be 0.27 feet/year. In addition, the seawall resulted in an additional 652 square feet of placement loss from the footprint of the structure on the public beach. During the 22-year lifespan of the project 1,372.8 square feet of beach will be lost. For the economic analysis the beach in front of the Las Brisas project is considered a subset of the larger Fletcher cove beach.

Beach sand mitigation

A fee of $22,977.36 based on the in-lieu fee beach sand mitigation PGD was required to mitigate for the loss of sand impounded by the seawall. In the Las Brisas staff report, the Coastal Commission states:

> The Commission also expressed concern because the In-Lieu Beach Sand Mitigation Fee formula that has previously been used to calculate the amount of fee to charge to mitigate the adverse effects of shoreline protective devices does not fully mitigate those impacts, and does not mitigate the impacts to public recreation and access from the physical beach loss at all (CCC 2005).

Consumer surplus value of a beach visit

To determine the value for the lost recreation, the Coastal Commission contracted independent economist Dr. Phillip King to provide an analysis of the lost recreational value that would result from the construction of the seawall. King applied the amenity-based benefit transfer method. King assigned a value of $14.00 for an individual's visit at a "perfect" beach. King (2005) adjusted the consumer surplus from Chapman and Hanneman (2001) from $13 to $14 ($2005) by subjectively balancing inflation with approximate consumer surplus values from the Southern California Beach project. King used the amenity-based model based on weighted amenity values (weather, water quality/surf, facilities and services, availability of substitutes), growth in numbers of beach visitors and discount factors to estimate a beach value of $6.81 ($2005) per visit per visit (48.7% of the study site) (King 2005). Table 4.9 shows the amenity point values and weights to transfer the value of the "perfect" study site to the policy site.

King (2006) later used the amenity-based benefit transfer method to find a consumer surplus value of $11.18 (per person per visit) for Huntington Beach using the same amenity point values and weights in Table 4.8. This is inconsistent with his benefit transfer approach for Las Brisas. If King uses Huntington Beach as a "perfect beach," then the amenity point values should all be one hundred percent. Based on King's amenity point values for Huntington

Beach and using Chapman and Hanemann's (2001) consumer surplus value for Huntington Beach as the study site, the consumer surplus for a "perfect beach" can be estimated and used as the reference beach (study site) for all future amenity-weighting. Applying King's $14 ($2005) consumer surplus value yields a reference beach value of $17.54 ($2005). Adjusting Chapman and Hanemann's value to $19.71 ($2005) solely for inflation yields a reference beach value of $24.69 ($2005). Using the reference beach consumer surplus value and applying King's amenity value approach yields a consumer surplus value at Las Brisas of $8.54 ($2005) without adjusting for inflation or $12.02 ($2005), if properly adjusted for inflation.

<u>Recreational use (attendance)</u>

The project site is located on a public beach utilized by local residents and visitors for a variety of recreational activities including swimming, surfing, jogging, walking, surf fishing, beachcombing and sunbathing. King estimated the attendance at the beach to be 40,460 visitors over 100 days during the high season (approximately June, July and August). The City of Solana Beach does not track attendance at Fletcher Cove. King derived attendance from estimations by City lifeguards and use of a recent parking study for a park on the bluff above the beach (King 2005).

<u>Erosion value loss model: amenity-based</u>

The amenity-based model was used to estimate lost consumer surplus. Two amenities (beach width and overcrowding) were adjusted proportionately to the reduction of beach width, and these changes were used to calculate the consumer surplus lost by all beach visitors from the narrower beach. In the first year, this results in a $0.25 loss in consumer surplus per visitor and increases to a $0.31 loss per visitor after the fifth year of the project when the entire beach in front of Las Brisas is lost.

King avoids the issue of loss in attendance from beach narrowing in this amenity-based model by considering a total beach area that is larger than the project site. In King's approach, all visitors of Fletcher Cove and the beach in front of Las Brisas (Figure 4.7) suffer loss of consumer surplus as the beach area in front of the project narrows. It is implicit that when the entire beach is lost in front on Las Brisas that beach visitors move to Fletcher cover, where crowding is increased. In other cases where only the project area is considered, the amenity-based model should account for loss of beach attendance if the beach narrows to a point where the visitors cannot physically fit on the beach.

<u>Total in-lieu mitigation fee</u>

Based on the high season attendance, a yearly attendance growth (0.5%) over the 22-year project lifetime and incremental loss of consumer surplus per visitor, the total loss of consumer surplus during the high season was estimated at $207, 233.94 ($2005). The low season estimate is approximated at 20% of the high season or $41,447. The total lost consumer surplus resulting from the seawall was valued at $248,680.72 during the 22-year lifespan of the project (King 2005).

The Coastal Commission approved the shoreline armoring and included a special condition that required the applicant to pay an in-lieu mitigation fee of $331,977.36, which is the total that includes the sand mitigation fee of $22,977.36.

The benefit transfer for the consumer surplus of an individual beach visit should be based on a reference beach with 100% amenities adjusted for inflation, described above. This would yield a consumer surplus value of a beach visit of $12.02 ($2005). Using this CS value in the amenity-based erosion value loss model would increase the total lost value at Las Brisas from $284,000 to $501,000, a 43% increase (See Table 4.15).

<u>Cost of estimation</u>

The CCC contracted with Dr. Phil King to conduct this analysis for $5000.

<u>Las Brisas case study conclusions</u>

The Las Brisas case provides two important insights and shows one error regarding mitigation for adverse impacts on local shoreline sand supply. For the first time, the in-lieu beach sand mitigation fee accounts for both impoundment loss and lost recreational use of the beach. Second, the amenity-based model is used for the first time to determine the base consumer surplus for a beach visit and also to adjust the consumer surplus value of a beach visit as the beach narrows from erosion. The amenity-based method for value transfer fails to accurately apply a "perfect" reference beach or account for inflation in the amenity-based benefit transfer. As a result, a consumer surplus value of an individual beach visit is underestimated and resulted in an underestimate of the total in-lieu fee by 43%. The value of sandy beach ecological services was not considered.

Case study 2: Ocean Harbor House, Monterey, California

In 2004, the Ocean Harbor House project was the first case where the Coastal Commission applied a fee for the value of lost recreation to mitigate the impacts of beach loss from a seawall.

<u>Project description</u>

Ocean Harbor House is a condominium complex on Del Monte Beach in the City of Monterey. It was built in the late 1960s and mid-1970s and has been threatened by coastal erosion for almost 30 years. To secure permanent protection of the structure, the homeowners association applied to the city and the Coastal Commission for permits to build a revetment with a lateral length of 435 feet (CCC 2005) (Figure 4.8). Using the mitigation approach defined in CEQA, the Environmental Impact Review and Coastal Commission staff report determined that the only feasible alternative to protect the structure was through the construction of a seawall.

Using the footprint of the sea wall and an erosion rate of 2 feet/year, it was determined that the seawall would result in the loss of 1 acre (43, 560 square feet) of public beach over the 50 year life span of the seawall and that no onsite mitigation was available (CCC 2005).

Beach sand mitigation

The Coastal Commission staff used the PGD for In-Lieu Fee Beach Sand Mitigation to calculate the fee required to replace the sand. The staff report states:

> … the volume of sand that approximates the area of beach land lost to the project can be calculated (38,200 to 44,700 cy); if this sand volume and current market prices for sand were to be used as a basis for an in lieu fee to mitigate the loss of recreational beach area, the fee would range from approximately $1,031,400 to $1,206,900 (CCC 2005).

The Coastal Commission decided they could not assess this fee because the Monterey region lacks a regional beach nourishment program (CCC 2005). They also acknowledge that this fee would only mitigate the sand supply and would not address the lost recreational value from the beach loss.

> However, as discussed, no formal beach nourishment and mitigation program is in place in the southern Monterey Bay area. Moreover, although this fee estimate is based on a quantifiable, site-specific volume of sand and market condition, this estimation of the beach loss through a sand volume calculation <u>does not really address the recreational value of the anticipated one-acre of beach loss</u> (CCC 2005).

In the absence of a beach mitigation program, the Coastal Commission decided to require an in-lieu fee paid to the Monterey Peninsula Regional Parks District for acquisition of beach front dune property for public recreational use in the southern Monterey Bay to mitigate for the lost coastal recreation resulting from the seawall and because Monterey County lacks of a beach nourishment program.

Consumer surplus value of a beach visit

The Coastal Commission used a point transfer benefit transfer approach to determine the consumer surplus per individual beach visit. After considering consumer surplus values per person per visit ranging from $10.98 ($2001) to $70 ($2001), the consumer surplus for Huntington Beach (study site) of $13 per beach visit from Chapman and Hanemann (2001) was used to estimate the consumer surplus of a beach visit in Monterey (policy site) at the $13 ($2005) per person per visit. The Coastal Commission justified using the study site consumer surplus value at the policy site based on a qualitative assessment of tradeoffs between inflation and the differences in use and amenities between Huntington Beach and Monterey.

> Given even the low rate of inflation, this amount would be $1 to $2 higher today. Although the beaches in the City of Monterey are not as highly developed as Huntington Beach, there are kayak and other rentals available, a large beachside hotel exists, as well as a number of other visitor amenities (restaurants, shops, etc.) nearby. In addition, the beaches in Monterey have a high non-market consumer surplus value because of the generally wide, sandy quality of the beaches, and their location in an urbanized area that is an extremely popular visitor destination along the Central California coast. The $13.00 figure is probably a reasonable estimate for the consumer surplus of the beaches in the Monterey area (CCC 2005,p. 37).

Beyond the subjective adjustments used to justify the point transfer, the CCC made the same error as King (2005) when applying a point transfer from the study site to the policy site. Adjustment of the CS value for inflation using the consumer price index from $13.00 ($1990) is $19.71 ($2005), not a $1 to $2 difference as suggested by the Coastal Commission. The Coastal Commission may have underestimated the consumer price index difference adjustment by adjusting the value based on the publication date of Chapman and Hanneman (2001), which would yield the $1 to $2 difference they cited, instead of on the date of the valuation (1990).

Using the recommended amenity-based benefit transfer approach for Monterey beaches by applying reasonable amenity values and weights (Figure 4.9) based on the corrected reference beach consumer surplus value of $24.69 ($2005), a more accurate consumer surplus value of an individual beach visit is $13.50 ($2005).

Recreational use (attendance)

Recreational use at the beach was determined using Monterey State Beach attendance estimates. Monterey State Beach has three separate beaches approximately two miles apart. Activities at these beaches that are included in the attendance counts are beachcombing, kite flying, volleyball, surfing and kayaking. The annual average beach attendance between 2001 and 2004 was 968,287 visits over the 60.6 acres of state beach. A per acre average attendance was calculated as 15,978 visits/acre. The area affected by the revetment was one acre of beach midway between two primary areas of state beach so the per acre average of 15,978 visits/year was used.

Erosion value-loss model: area-based

The Coastal Commission used the area-based model to estimate the value of lost consumer surplus. Using a consumer surplus value of $13 per person per visit and the average annual attendance of 15,978 visits/acre, the annual value of one acre of beach was estimated at $207, 714/acre/year or $4.77/square foot/year. Based on an estimated loss of 870 square feet of beach per year, the lost consumer surplus was estimated at $4,148/year. This loss was applied linearly over 50 years for a lost consumer surplus of $5.3 million over the project lifetime. Using a point transfer BT that accounts for inflation at the study site increases the CS value for an individual beach visit to $19.71 and would have increased the lost recreational value at OHH from $5.3 million to $8 million over the project lifetime (Table 4.10).

The amenity-based method applied to OHH produces a substantially lower total in-lieu mitigation fee. The consumer surplus value for an individual beach visit using the amenity-based benefit transfer is $13.50 ($2005). Using this CS value and the amenity-based erosion value loss model, the total lost recreational value is $2,680,000.

Loss of beach visits due to lack of physical space on the beach at OHH is irrelevant because the daily attendance is so low. The daily attendance of beach visitors at OHH is just over 43 visitors per day. Making a conservative assumption that a beach visitor needs at least 18 square feet (the size of an average beach towel), 43 visitors would only require 780 square feet. At OHH, there would be at least 870 square feet of beach until the last year of the project lifetime. This does not account for beach visitors changing their site choice due to the narrow beach. At other beaches with higher daily attendance, loss of beach visitors due to lack of physical space should be accounted for. The amenity-based model does not account for site choice so it cannot account for loss of visitors who prefer wider beaches.

Total in-lieu mitigation fee

Applying this consumer surplus value and the number of visits over a 50 year period resulted in a total mitigation fee of $5.3 million for the value of lost recreation over the lifetime of the project. The homeowners challenged the Coastal Commission authority to assess the fee and the validity of their methodology, but the California State Appellate Court upheld the Coastal Commission's decision and methodology (OHH 2008).

The area-based method overestimates the beach value because it assumes every square foot of the beach is valued equally and fails to account for adjustments made by beach visitors as a beach narrows. Given the low average daily visitation of 43 beach visits, it is unlikely that the relatively small loss of beach in the early years of the project will even be noticed. The amenity-based model more accurately reflects the relatively small loss of consumer surplus when the armoring is first installed.

Valuing ecological services

The consumer surplus for the ecological services of sandy beaches was not directly accounted for. The Coastal Commission noted that the consumer surplus value used for beach recreation was conservative because habitat and aesthetic values were not included.

Cost of estimation

The in-lieu mitigation fee approach was used in the estimation completed by the Coastal Commission staff as part of the staff report for the Coastal Development Permit. An outside consultant was not used. The cost of estimation was the opportunity cost of Coastal Commissions staff time.

Ocean Harbor House case study conclusions

The Coastal Commission approach at OHH has several shortcomings. The point transfer used to estimate the consumer surplus of an individual beach visit underestimated the value at the policy site because inflation was not considered. The area-based erosion value-loss model likely overestimates the total consumer surplus of the beach as it erodes. Using the amenity-based benefit transfer approach, the consumer surplus value for an individual beach visit is $13.50 and the total in-lieu beach mitigation fee using the amenity-based erosion value method is $2,680,000, which is 51% lower than the fee assessed by the Coastal Commission.

The OHH case also provides additional insights about how the Coastal Commission approaches mitigation for adverse impacts on local shoreline sand supply. First, the in-lieu fee beach sand mitigation was not applied because there was no regional beach nourishment program. Second, it shows that fees to mitigate for the value for lost beach recreation from shoreline armoring impacts can be determined, assessed and upheld in court if reasonable methods are used. Last, the value of sandy beach habitats is acknowledged to show that the consumer surplus of a beach visit is conservative.

Case Study 3: 629-633 Circle Drive, Solana Beach, California

In 2006, the Coastal Commission required mitigation for the adverse impacts from a seawall for a project one half mile from the Las Brisas project. This project straddles the border of the Solana Beach and Encinitas. The homes are located in Solana Beach, but the beaches at the base of the bluff are in Encinitas.

Project description

The Coastal Commission determined that bluff erosion due to wave action threatened the structure and conditionally permitted a 145 -foot long, 22-foot high seawall at the base of the bluff on the public beach (Figure 4.10). At this site the long-term average annual retreat rate was determined to be 0.4 ft/yr. The seawall footprint would result in the placement loss of 362.5 square feet, and 1,276 square feet of beach will be inundated and will not be replaced by new inland beach area during the 22-year lifespan of the project. During the 22 -year lifespan a total of 1,638.5 square feet of beach will be lost.

Beach sand mitigation

A fee of $21,420.00 based on the in-lieu fee beach sand mitigation PGD was required to mitigation for the loss of sand that would have been added to the littoral cell were it not for the proposed seawall.

Consumer surplus value of a beach visit

To mitigate for lost recreation, the consumer surplus for a beach visit was determined using the amenity-based method. The same weighted amenity values used by King (2005) at the Las Brisas project were used for this project. The consumer surplus value for a beach visit was adjusted to reflect the day-use-value developed by King for Encinitas beaches and set at $8 per person per visit. The adjustment from the Las Brisas value of $6.81 ($2005) to $8 ($2006) is based on verbal communication with City of Encinitas staff but is not explicitly described (CCC 2005). Adjustment for inflation alone, based on the Consumer Price Index, would increase the consumer surplus from $6.81 ($2005) to $7.03 ($2006).

The amenity-weighted consumer surplus value corrected using the 100% amenity reference beach, as described in the Las Brisas case, and inflation is $12.41 ($2006) per individual beach visit.

Recreational use (attendance)

Beach attendance was based on vehicle and attendance counts from the City of Encinitas website and used to generate a high season (June through September) average of 53,602 visits per month (CCC 2005).

Erosion value loss method: amenity-weighted

Lost consumer surplus was estimated using the amenity-based model and used the identical approach King applied at Las Brisas with two exceptions. The initial consumer surplus value of a beach day was subjectively adjusted to $8.00

($2006) per visit, and an attendance count of 53,602 visits per month during the high season was used. As in Las Brisas, the low season was estimated at 20% of the high season.

Total in-lieu mitigation fee

Based on this modification from the Las Brisas analysis and the calculation of beach loss for this site, the loss of recreational value over the 22-year lifespan of the project was determined to be $198,133.74 (Table 4.11).

Adding this to the $21,420.00 for the beach sand mitigation, the total in-lieu mitigation fee was $219,553.74.

Correcting for inflation and the appropriate reference beach increases the consumer surplus to $12.41 ($2006) per individual beach visit and the total lost consumer surplus over the project lifetime to $307, 351.86, which is 36% higher than the value calculated by the Coastal Commission. Inclusion of the beach sand mitigation fee increases the total in-lieu mitigation fee to $328,771.86.

Cost of estimation

This estimate was also conducted by the CCC staff and incurred no outside consultation fees.

Circle Drive case study conclusions

The 629-633 Circle Drive case continues the use of the amenity-based method for the benefit transfer to determine the consumer surplus of a beach day and for the lost consumer surplus. The consumer surplus was adjusted from Las

Brisas value of $6.81 to $8 subjectively. Lost recreational opportunity is undervalued by 36% because the methodological errors found in the Las Brisas case were also applied to this project. The staff report also notes that the total in-lieu mitigation fee is underestimate because it fails to account for aesthetic impacts and lost lateral (along the beach) access (CCC 2005). This project does not mention or consider the loss of ecological services of the beach.

Case Study 4: 417 & 423 Pacific Avenue, Solana Beach, California

In 2008, the Coastal Commission received another permit request for a seawall to protect ocean front bluff top homes in Solana Beach.

<u>Project description</u>

The applicants requested a permit to construct a 170-foot long, 35-foot high seawall at the base of the bluff. The Coastal Commission determined that the proposed seawall would result in 340 sq. ft. of placement loss due to the footprint of the seawall (Figure 4.11).

<u>Beach sand mitigation</u>

Using the PGD, the impoundment loss was determined to be 3,073.60 cubic yards of sand. This figure was reduced by 466 cubic yards to account for sand contributed to the beach by recent bluff failures (CCC 2008). The in-lieu beach sand mitigation fee was determined to be $61,164.64 to be paid to SANDAG for their beach nourishment program.

Erosion value loss method: interim linear value model

In this case, the Coastal Commission found that they could not apply Dr. King's study for Fletcher cove to this project site because the Coastal Commission decided that the character of the beach, the number of users, the width of the beach and several other variables were too different (CCC 2008).

To more precisely determine the economic costs to beach recreation from shoreline armoring, the City of Solana Beach began a site-specific beach recreational values study in 2007. While the beach recreation study is underway, the City of Solana Beach established an interim in-lieu fee program to mitigate adverse impacts associated with shoreline armoring (City of Solana Beach Resolution 2007-042). The interim program requires $1000 per linear foot of armoring to be assessed and that the applicant agrees to modifications to the fee once the economic study is completed and a more site-specific fee can be assessed. The mitigation fee is to be directed to the City of Solana beach for use in public access and recreational projects (CCC 2008). The fee used in the interim linear value method is independent of consumer surplus value per beach visit and the amount of recreational use (attendance).

Total in-Lieu mitigation fee

In this case the interim mitigation fee for the 170-foot seawall is $170,0000 for the 22-year lifetime of the project. The beach sand mitigation fee of $61,164.64 was paid separately for use for beach projects in San Diego County. The interim fee is lower than all other cases when lost consumer surplus is converted to a linear value (Table 4.12).

Pacific Drive case study conclusions

The Pacific Drive case shows the Coastal Commission abandoning the amenity-based approach because the beach was too different from Las Brisas. Instead the Coastal Commission used a method based on a flat fee per linear foot of beach impacted by the shoreline protective device to establish an interim mitigation fee. The fee is designed as interim mitigation while the City of Solana Beach conducts a site-specific study for Solana Beach City beaches.

Case Study 5: City of Solana Beach site specific study

The City of Solana Beach is the first city in California to try to develop a site specific study of city beaches to empirically determine the consumer surplus values of a beach visit, measure annual attendance and develop a method to estimate lost consumer surplus from beach loss due to the construction of shoreline protective devices.

Project description

The City of Solana Beach has 1.7 linear miles of beach, which is 0.15% of California's entire coastline and 0.25% of California's sandy beaches. The City of Solana Beach is the last city in San Diego County without a Local Coastal Plan (LCP). Approval of an LCP by the Coastal Commission transfers permitting authority to the city. As part of the LCP, the City of Solana Beach is attempting to establish a local in-lieu sand mitigation fee program to mitigate for lost sand supply and coastal recreation from shoreline armoring. Studies to determine average erosion rates have been completed as part of the LCP process. The City of Solana Beach hired an independent consultant and formed a citizen committee to determine the economic values associated with coastal recreation in Solana Beach. The request for proposals (RFP) for the project was $100,000. The goal of the study is to empirically derive site-specific consumer surplus values for beach use and annual attendance figures. They plan to derive a consumer surplus value (per person per visit) for coastal recreation using the travel cost method. Attendance will be determined by counting beach goers using a randomized schedule over a one-year period.

The study to determine consumer surplus values and beach attendance began in 2007. The study remains in draft form as of June 29, 2011 when the City of Solana Beach held a public comment hearing on their Local Coastal Plan. According to the City of Solana Beach staff report, the beach mitigation fee was not included in the LCP because they were "unable to agree to a set fee" (City of Solana Beach 2011). On March 7, 2012 the CCC approved the Solana Beach LCP and required them to complete the site specific consumer surplus study in 18 months. After spending $100,000 and four years, the City has not yet been able to complete a site-specific single site travel cost study to estimate consumer surplus values for the beaches in Solana Beach, and an erosion value-loss model has yet to be addressed.

Case study conclusions

The case studies show that the Coastal Commission is taking an inconsistent approach to determine the sand loss from impoundment and placement loss by using the 2005 procedural guidance document. Comparison of the values and methods used on the project described above shows that the Coastal Commission is not using a consistent methodology to determine the lost recreational values from shoreline armoring.

Coastal Commission mitigation methods: a review

As shown in the case studies above and summarized in Table 4.13 the Coastal Commission has subjectively transferred benefits to determine the consumer surplus of a beach visit and to determine the loss in consumer surplus as a beach erodes. All consumer surplus values originated from Chapman and Hanneman (2001) but were either subjectively altered or adjusted using the amenity-based method with a low reference value. Four approaches have been applied to determine the value of lost beach recreation: 1) the Ocean Harbor House (OHH) project used the area-based method, 2) Las Brisas and Circle Drive projects used the amenity-based method, 3) the Pacific Drive project used a flat fee based on the length of the seawall as an interim fee, and 4) the City of Solana Beach attempted but has yet to complete a site-specific study using single site travel cost method to estimate consumer surplus for their 1.7 miles of beach. To date, the mitigation projects include only in-lieu mitigation for lost recreational value. The lack of research on the value of sandy beach ecosystems limits the assessment of fees for beach ecosystem services, but only two of the projects acknowledge that this results in a conservative estimate for the value of lost beach.

Review of consumer surplus values

In all cases that used benefit transfer, the consumer surplus from Chapman and Hanemann (2001) was used as the study site then adjusted for the policy site consumer surplus value using subjective and qualitative approaches. At OHH, the Coastal Commission may have underestimated the consumer price index difference adjustment by adjusting the value based on the publication date of Chapman and Hanneman (2001), which would yield the $1 to $2 difference they cited, instead of on the date of the valuation (CCC 2005). At Las Brisas, King used the imperfect beach at Huntington Beach to represent a "perfect beach", instead of using Chapman and Hanneman and Huntington Beach's weighted amenities to establish a "perfect beach" to be used as the study site. The Las Brisas value was then adjusted for the Circle Drive case study. At Pacific Drive, the interim linear value of $1000 per linear foot of shoreline armoring is less than all other cases when converted to value per linear foor (Table 4.12). All cases resulted in an underestimate of the consumer surplus and represent values below the consumer surplus values found in the literature (Figure 4.12). The impact of these underestimates on the total in-lieu mitigation free is discussed below.

Consumer surplus of a beach visit

Table 4.14 shows the range of values for the consumer surplus per person per visit for California beaches used by the Coastal Commission and in the published literature. The lowest value ($6.81) is thirteen times less than the highest value ($90.58). Table 4.14 also shows the inflation-adjusted values for Las

Brisas and OHH. Accounting for inflation increases the consumer surplus by up to 34%.

Table 4.15 shows how the choice of consumer surplus value can affect the total value for lost recreation at OHH and Las Brisas. Selecting the appropriate consumer surplus value for the beach under consideration can have a dramatic impact on the total mitigation fee. For example, based on the range of consumer surplus values shown in Table 4.14, the lost recreational value at OHH could range from $2.8 million to $37 million. At Las Brisas, the lost consumer surplus could range from $284,000 to $3.78 million. If King (2005) used the reference beach adjusted for inflation shown in Table 4.14 the lost recreational value at Las Brisas would increase from $284,000 to $501,000. Using a consumer surplus value that accounts for inflation alone would increase the lost recreational value at OHH from $5.3 million to $8 million.

A review of the Coastal Commission projects shows that the consumer surplus values applied in permits are lower than the range of values in the literature (Figure 4.12). It could be argued that the consumer surplus values for narrow eroding beaches should be lower than wide sandy beaches that are usually the subject of the studies. However, the lower values used by the Coastal Commission are a result of benefit transfer error, not necessarily adjustment to a lower value policy site. As shown in the OHH and Las Brisas case studies, those errors include failure to adjust consumer surplus values for inflation, subjective adjustment of values, and use of an imperfect lower value reference beach.

Sensitivity to project lifetime, erosion rate and beach width

Beyond the economic methods and models used to determine the lost value of beach ecosystem services from shoreline armoring, three additional parameters can affect the total in-lieu mitigation fee. Project lifetime is a policy parameter that does not change the mitigation fee per annum but affects the net present value of the fee applied at the time of the permit. Beach width and erosion rate used in the erosion value-loss model will affect the number years before the point when the maximum annual fee is reached, which will affect the total mitigation fee. A series of counterfactuals are shown for OHH and Las Brisas to show how these parameters can change the total in-lieu mitigation fee.

Project lifetime

The CCC establishes project lifetime during the permitting process. Project lifetime can vary from 22 years to 100 years. For in-lieu mitigation projects, the project lifetime can be established for a number of reasons, including the estimated time before the beach is completely lost or the remaining economic life of the structure. Project lifetime has a linear relationship with loss of consumer surplus.

As shown in Table 4.16 the project lifetime controls the upfront fee that an applicant is required to pay for mitigation at the time a permit is issued. Increased project lifetime increases the upfront cost, even when a discount rate is applied because additional years of lost consumer surplus are not reflected in the NPV. No projects have reached their full project lifetime, so it is unclear what the CCC will require when a project lifetime expires. Variation in project lifetime makes comparison of in-lieu mitigation fees for similar projects challenging for the Coastal Commission and the public.

Beach width

California beaches subject to approval of shoreline protective devices are inherently narrow enough that coastal development is threatened. The loss of beach width due to passive erosion reduces the recreational value (loss of area or amenities) over time (King 2001). The beach width is determined at the time of permitting. Beach width is highly dynamic on daily, seasonal and decadal time scales. Beach width is also affected by prior shoreline modifications at adjacent areas or within the littoral cell (Griggs 1998).

In either method (area-based or amenity-based), the total lost consumer surplus is dependent on total amount of beach lost. At the point where the beach width equals zero, the lost consumer surplus reaches its annual maximum and is constant for the duration of the project lifetime. If the preexisting beach is wide and the entire beach is lost during the project lifetime, there is more beach to lose and therefore more consumer surplus to be lost. Table 4.17 shows how beach width effects lost recreational value. If the preexisting beach at Las Brisas was 30.8 feet wide and beach was lost each year during the 22-year project lifetime, the mitigation value would have increased by 22%. At OHH, if the beach width was 8.5 feet, resulting in total beach loss by year 5, the lost consumer surplus would hold constant for the remaining 45 years of the project lifetime, and the mitigation value would decrease more than four times. The determination of beach width and the preexisting state of beach width will influence the mitigation value. If the beach is already narrow due to pre-existing shoreline alterations or seasonal variation, the lost recreational value will be reduced.

Erosion rate

The beach erosion rate describes that average annual rate of beach narrowing (feet per year) and controls the total beach area lost per year. Erosion rate is determined through the permitting analysis to justify the shoreline protective device. In both methods (area-based or amenity-based), the total lost consumer surplus is dependent on amount of beach lost. Erosion rate controls the amount of time before the beach width equals zero and annual recreational loss is maximized. Table 4.18 shows the effect of erosion rate on lost recreational value. Because the beach at Las Brisas is relatively narrow and the percentage of beach lost compared to the adjacent beach is small, lost recreation value is not sensitive to erosion rate. Doubling the erosion rate at Las Brisas decreases the lost recreational value by 5%. Reducing the erosion rate by 90% increases the lost recreational value by 14%.

At OHH, where the beach is wide compared to Las Brisas, the lost recreational value is more sensitive to erosion rate. For the area-based method at OHH, lost recreational value is linearly related to erosion rate. A 90% reduction in erosion rate leads to a 90% reduced lost recreational value. If the erosion rate is higher, the entire beach will be lost before the project lifetime is completed and the recreational loss will be at its maximum for the remaining years. For example, if the erosion rate at OHH doubled, the beach would be lost at year 25 and lost recreational value is at the maximum for the final 25 years of the project lifetime, leading to a lost recreational value of over $7.9 million, an increase of 33% over the value assessed by the Coastal Commission. Using the amenity-based method at OHH with the erosion rate doubled increases the lost recreational value from $2,600,000 to $4,200,000, an increase of 39%. Erosion rate is more important on wide beaches than narrow beaches, because wide beaches are more sensitive to the year when the maximum lost recreational value is reached. This shows that the determination of beach width at the outset of the permitting process is important.

Conclusions and Recommendations

The California Coastal Commission is required to eliminate or mitigate adverse impacts on local shoreline sand supply when approving the construction of shoreline protective devices (CCA §30253). In-lieu mitigation should compensate for the flow of all ecological and recreational services provided by sandy beaches. Two possible approaches to determine the mitigation fee are a supply-based approach based on the NRDA HEA model or demand-based approach based on the consumer surplus of lost services.

The HEA model provides a supply-based service for service model. The HEA model would require that mitigation for lost ecosystem services be equal to the cost of restoring those ecosystem services by a beach dredge and fill project. This approach is limited by the lack of research on beach ecosystem functions and is challenged by the mismatch of spatial and temporal scales of permitting for coastal erosion and beach dredge and fill projects. The demand-based approach using consumer surplus values is also limited by the lack of research on the ecological functions of beaches, but can be used to determine lost value recreational values on narrowing beaches. In recent cases, the Coastal Commission has included compensatory mitigation for lost recreation resources but has not used consistent methods to determine the value of a beach visit or model to determine the loss of that value over time. This has resulted in cases where mitigation was both over and underestimated and beach ecosystem services were not given full consideration (Table 4.13).

The consumer surplus of an individual beach visit is well studied in California and the literature provides a large number of studies and a wide range of values that could be used as study sites for benefits transfer. To date, the Coastal Commission has used Chapman and Hanemann's (2001) study of Huntington Beach as the study site for every project with a consumer surplus value of $13 ($1990) per person per visit, and then adjusted that value subjectively and without adjusting for inflation. As a result, the consumer surplus values used by the Coastal Commission are lower than the range of beach values found in the literature (Figure 4.12).

The Coastal Commission's choices for estimating lost consumer surplus value on narrowing beaches are limited. Random utility models (RUM) are too costly and time consuming for all but very large projects. Site-specific studies often prove to be also impractical – being both costly and time consuming. The City of Solana Beach spent $100,000 to conduct a study to estimate the value of 1.4 miles of beach and after 5 years has yet to produce any conclusive results. On the other hand, the California Coastal Commission used an area-based method that built upon values of the literature to estimate lost beach value at the Ocean

Harbor House. In a subsequent ruling, the California State Appellate Court that deemed the method as a reasonable method to approximate lost consumer surplus (OHH 2008) and provides a simple means to account for lost consumer surplus on an eroding beach but overestimates the loss (Figure 4.5).

More recently, the Coastal Commission has applied an amenity-based benefits transfer model (King 2005) that improves upon earlier attempts to adapt values from the literature to beaches in question. Given the Coastal Commission's limitations on time, expertise, and funding for economic consultants, King's amenity-based model could provide a reasonable and practical approach to estimate consumer surplus values at the project scale but to do so requires further refinements in the way model weights and values are derived. The amenity-based model provides a mechanism to account for variation in beach attributes, water quality and substitution and those values can be adjusted to reflect reduced consumer surplus to beach visitors as the beach narrows but the values must be empirically grounded. Like any benefits transfer model, the results are only as reliable as the values used for the study site. Values and weights for reference beaches could be assigned more empirically through review of the literature, including Pendleton, Mohn et al. (2011), combined with selected contingent valuation model studies on user preferences. In practice, even the application of sophisticated economic analysis to natural resource damage assessment is subject to judicial review, political debate, and even public negotiation. While multi-site models like the RUM may provide more accurate estimates of consumer surplus change, these models are likely to be too complicated to serve as points of departure for public review and discussion. Despite shortcomings when compared to more sophisticated models, the amenity-based model has the advantage of being simple enough to be understandable by policy analysts, decision makers and the public. This allows the method, benefit transfer, baseline values and weights to be discussed publicly and even negotiated in the decision making process.

As shown at OHH (2005), Chapman and Hanneman (2001) and Pendleton, Mohn et al. (2011) the potential economic cost of beach loss can be millions of dollars. In these cases, the Coastal Commission should either fund or require the project proponent to fund more sophisticated analysis conducted by trained economists.

To date, the Coastal Commission has failed to include estimates of the economic values for lost of ecological services that may occur when beaches are lost. The failure stems largely due to the lack of established scientific description of the ecological functions of the beach or an explicit model for the valuation of those services. Mitigation that is limited to beach recreation is an underestimate of the total economic value of beach ecosystem services because these values are greater than zero (MA 2005). In some cases Coastal Commission has acknowledged the value of beach ecosystems but has not explicitly articulated where valuation is missing. This chapter provides a conceptual model of the total economic value of beach ecosystem services to show what values are not considered in the final valuation. There is a clear and practical need for more research on the ecosystem functions and services provided by sandy beaches and the non-market values associated with those services.

Beyond the economic methods and models used to value the loss of beach services on an eroding beach, three additional parameters deserve consideration in an in-lieu mitigation valuation. Project lifetime is a policy parameter that is dependent on permit specific issues, ranging from the lifetime of the beach to the lifetime of the structure the shoreline protective device is protecting. Variation in project lifetime inhibits the ability for the Coastal Commission to compare projects. Short project lifetime reduces the upfront mitigation cost required from the permit applicant and may require future permitting for mitigation beyond the project lifetime. Project lifetime should be extended to the maximum lifetime that the shoreline protective device will be allowed.

Sensitivity to pre-existing beach width and average erosion rate should be considered for every project. Beach width is highly variable on multiple temporal scales. Erosion rate relative to pre-existing beach width and the project timeline control when the annual mitigation fee is maximized and can influence the total in-lieu mitigation fee.

The Coastal Commission has been inconsistent in its method of determining mitigation fees for loss of beach recreation. They have used different and subjective consumer surplus values for a beach visit and different methods for determining the loss of value on a narrowing beach. Development of an academically based empirical values for beach attributes and a procedural guidance document based on the recommendations above will standardize the methods and models applied to in-lieu mitigation fees and will make the permit process more consistent and legally defensible.

Sandy Beach Ecosystem Services	Direct Use Value	Indirect Use Value
Sediment storage and transport;		x
Wave dissipation and associated buffering against extreme events (storms, tsunamis);		x
Dynamic response to sea-level rise (within limits);		x
Breakdown of organic materials and pollutants;		x
Water filtration and purification;		x
Nutrient mineralization and recycling;		x
Water storage in dune aquifers and groundwater discharge through beaches;		x
Maintenance of biodiversity and genetic resources;		x
Nursery areas for juvenile fishes;	x	x
Nesting sites for turtles and shorebirds, and rookeries for pinnipeds;	x	x
Prey resources for birds and terrestrial wildlife;		x
Scenic vistas and recreational opportunities;	x	
Bait and food organisms;	x	x
Functional links between terrestrial and marine environments in the coastal zone.		x

Table 4.1 Sandy beach ecosystems services by use value type.

Amenity	**Amenity Point Value**	**Weight**	**Weighted Amenity Value**
Weather (W)	.85	.20	.968
Water Quality (WQ)	.75	.20	.944
Beach Width and Quality (BWQ)	.20	.15	.786
Overcrowding (C)	.50	.15	.901
Other Amenities (A)	.50	.15	.901
Substitutes (S)	.30	.15	.835
Total Index Value	**--**	**1**	**.487**

Table 4.2 Example of weighted amenity values for the policy site beach.

CCC Demand model requirements
Beach recreation CS value (per person per visit)
Benefit transfer method
Beach attendance count (annual)
Beach erosion-value loss model
Ecological Services CS value

Table 4.3 Requirements of a demand model to value lost beach value.

Beach	Consumer Surplus for a Beach Visit (per person, $2005)	Author
Cabrillo-Long Beach	$12.16	Leeworthy and Wiley (1993)
Solana Beach	$17.57[1]	King (2001)
Huntington Beach	$19.71[2]	Chapman and Hanemann (2001)
Encinitas	$22.56[1]	King (2001)
Carpenteria	$24.70[1]	King (2001)
Santa Monica	$27.36	Leeworthy and Wiley (1993)
San Diego – 3	$28.27	Lew and Larson (2005)
San Clemente	$30.96[1]	King (2001)
San Diego – 2	$36.73[3]	Lew (2002)
Pismo State Beach	$39.04	Leeworthy (1995)
Leo Carillo State Beach	$77.39	Leeworthy and Wiley (1993)
San Onofre State Beach	$85.39	Leeworthy (1995)
San Diego	$90.58	Leeworthy (1995)

1) midpoint between two methods
2) corrected for inflation using CPI
3) cited by authors and preferred value

Table 4.4 Summary of existing site-specific study estimates of consumer surplus for a beach visit in California.

Input parameters	Units
Size of injury	Area
Year of injury	Year
Level of services in injury year	Percentage *(relative to baseline services)*
Year recovery starts	Year
Services at maximum recovery	Percentage *(relative to baseline services)*
Year recovery starts	Year
Year net service gains start	Year
Shape of recovery function	Function *(usually assumed to be linear)*

Table 4.5 Input parameters required in a HEA model (NOAA 2000).

Requirement	Beach ecosystem services
Primary services are biological	Not at present
Quantification of services lost	No
Estimate of recovery rate is available	No
Suitable site exists	Yes

Table 4.6 Assessment of HEA requirements for sandy beach ecosystem services.

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Project/ year	**Project Lifetime** (years)	**In-Lieu Beach Sand Mitigation Fee**	**Attendance Total / Source** (Annual visits)	**Consumer Surplus Value /Source** (per visit per person)	**Consumer Surplus Loss Model**	**Cost of estimation / Agency**	**Total Recreation Fee**
Ocean Harbor House (OHH) (2004)	50	0[1]	15,978 (CA State Parks)	$13.00 (American Trader)	Area-based	Staff time[2] (CCC staff)	$5,3,000,000
Las Brisas (2005)	22	$22,977.36	92,460 (King)	$6.81 (King, based on OHH)	Amenity-based	$5000 (CCC consultant)	$309,000
Circle Drive (2006)	22	$21,420.00	53,602/mnth[3] (City of Encinitas)	$8.00 (City of Encinitas, adjusted from Las Brisas)	Amenity-based	Staff time[2] (CCC staff)	$198,132
Pacific Avenue (2008)	22[4]	$61,164.64	Not applicable	$1000/linear foot[5]	Linear	$100,000 (City of Solana Beach consultant)	$170,000[6]

1) No fee established because Monterey lacks an appropriate beach program
2) Determined by Coastal Commission staff. No consulting fees.
3) Average monthly attendance during high season (June – September)
4) The in-lieu beach recreation fee is provisionally established for a 73-year period
5) Interim in-lieu fee program adopted by the City of Solana Beach
6) Proposed interim mitigation fee

Table 4.7 California Coastal Commission in-lieu beach sand and beach recreation mitigation fee.

Monterey Beach

Amenity	Amenity Point Value	Weight	Weighted Amenity Value
Weather	50%	20.00%	87.1%
Water Quality	80%	20.00%	95.6%
Beach Width and Quality	90%	15.00%	98.4%
Overcrowding	90%	15.00%	98.4%
Other Recreational Amenities	25%	15.00%	81.2%
Availability of Substitutes	30%	15.00%	83.5%
Total Index Value		100%	54.7%
Monterey	$ 13.50		
Maximum "Perfect Beach"	$ 24.69		

Figure 4.9 Amenity values and weights of Monterey beaches.

Huntington Beach / Perfect Beach

Amenity	Amenity Point Value	Weight	Weighted Amenity Value
Weather	85%	20.00%	96.8%
Water Quality	75%	20.00%	94.4%
Beach Width and Quality	95%	15.00%	99.2%
Overcrowding	75%	15.00%	95.8%
Other Recreational Amenities	95%	15.00%	99.2%
Availability of Substitutes	60%	15.00%	92.6%
Total Index Value		100%	79.8%
American Trader	$ 14.00		
Maximum "Perfect Beach"	$ 17.54		

Table 4.9 Weighted amenity values for Huntington Beach used to find a "perfect" reference beach. Based on King (2006).

Method	Consumer Surplus ($/person/ visit)	Lost Recreation Value ($2005)	Net Present Value[1] ($2005)
Area-based	13.00[2]	5,300,000	2,150,000
	19.71[3]	8,000,000	3,250,000
Amenity-based	13.00	2,570,000	960,000
	13.50[4]	2,680,000	1,000,000

1) Based on a 3% discount rate and project lifetime of 50 years
2) CS value used in the CCC permit process for OHH
3) CS value adjusted for inflation using BLS Consumer Price Index
4) Adjusted consumer surplus values corrected for "perfect" reference beach and inflation.

Table 4.10 The amenity-based method applied to Ocean Harbor House.

Season	**NPV Lost consumer surplus** ($2006)
High Season Loss	$165,109.78
Loss Season Loss	$33,021.96
Total Loss	**$198,131.74**

Table 4.11 Lost consumer surplus for Circle Drive project using amenity-based method.

Project	Value ($ per linear foot)[1]	Difference[2]
Pacific Avenue	1000	--
Las Brisas	2072	+52%
Ocean Harbor House[2]	1612	+38%
Circle Drive	1366	+27%

1) Not corrected for inflation
2) Adjusted for a 22-year project lifetime

Table 4.12 Comparison of consumer surplus value per linear foot of shoreline armoring.

Valuation Parameters	OHH	Las Brisas	Circle Drive	Pacific Avenue	City of Solana Beach
Valuation method	BT: Point	BT: Amenity	BT: Amenity	Linear value	Single-site TCM
Study Site	Huntington Beach[1]	Huntington Beach[1]	Las Brisas		Site specific
CS value used[2]	$13.00	$6.81	$8.00	$1000	n/a
Recommended CS value[2]	$13.50	$12.02	$12.41	--	--
Difference[2]	**+$0.50**	**-$5.21**	**-$4.41**	**--**	**--**
Erosion value loss model	Area	Amenity	Amenity	Linear	n/a
CS Lost	$5,300,000	$284,000	$219,554	--	--
Recommended CS Lost	$2,680,000	$501,275	$307,352	--	--
Difference[3]	**+$2,620,000**	**-$217,000**	**-$87,798**	**--**	**--**
Attendance Source	State Park	City	City	n/a	Site specific study
Beach ecosystem values	Acknowledged	Acknowledged	No	No	No

1) Chapman and Hanneman (2001)
2) Consumer surplus per individual visit
3) Project lifetime for OHH is 50 years. Project lifetime for other projects is 22 years.

Table 4.13 Comparison of methods and values used to estimate the in-lieu mitigation fees.

Amenity	Amenity Point Value	Weight	Weighted Amenity Value
Weather	85%	20.00%	96.8%
Water Quality	75%	20.00%	94.4%
Beach Width and Quality	20%	15.00%	78.6%
Overcrowding	50%	15.00%	90.1%
Other Recreational Amenities	50%	15.00%	90.1%
Availability of Substitutes	30%	15.00%	83.5%
Total Index Value		100%	48.7%
Maximum Value per Day	$ 14.00		
Fletcher/Las Brisas Value	$ 6.81		

Table 4.8 Weighted amenity value for the Las Brisas project (King 2005).

Consumer Surplus ($ /person/visit)	Source of Value ($ year of value)	Percent Change
6.81[1]	Las Brisas Amenity Weighted - Las Brisas ($1990)	--
10.18	Las Brisas Amenity Weights ($2005)	33%
8.54[2]	Las Brisas Amenity Weighted – Reference Beach ($1990)	--
12.02[3]	Las Brisas Amenity Weighted –Reference Beach ($2005)	29%
13.00	OHH – based on Chapman & Hanemann ($1990)	--
19.71[4]	Chapman & Hanemann ($2005)	34%
39.00[5]	Average consumer surplus for CA Beaches	--
50.00	High value from Pendleton and Kildow (2006) ($2006)	--
90.58	Leeworthy (1995)	--

1) Reference beach is modification of Chapman and Hanemann ($1990)
2) Based on a perfect beach consumer surplus maximum beach value of $17.54 ($1990)
3) Based on a perfect beach consumer surplus maximum beach value of $24.69 ($2005)
4) Corrected for inflation based on CPI
5) Average consumer surplus value based on literature review summarized in Table 4.4

Table 4.14 Description of the range of consumer surplus values, the source and the year on which that value was based and percent change resulting from inflation correction.

Consumer Surplus ($ /person/visit)	**OHH Lost Recreational Value** ($)	**Las Brisas Lost Recreational Value** ($)
6.81[1]	2,776,385	284,000 [1]
8.54	3,481,692	356,147
12.02	4,900,462	501,275
13.00[2]	5,300,000[2]	542,144
19.71	8,035,615	821,974
39.00	15,900,000	1,626,432
50.00	20,384,615	2,085,169
90.58	36,928,769	3,777,492

1) Value used by CCC for Las Brisas
2) Value used by CCC for OHH

Table 4.15 Effect of changes in consumer surplus value on total lost recreational value from passive erosion at OHH and Las Brisas.

Project	Project Lifetime (years)	Consumer Surplus ($/person/ visit)	Beach Lifetime (years)	Lost Recreation Value ($)	Net Present Value[1] ($)
Las Brisas	22[2]	6.81	5	284,000	207,000
	50	6.81	5	706,000	356,000
OHH	50[3]	13.00	50	5,300,000	2,150,000
	22	13.00	50	1,050,00	703,000

1) Based on a 3% discount rate and project lifetime
2) Values used in the CCC permit process for Las Brisas
3) Values used in the CCC permit process for OHH

Table 4.16 The impact of project lifetime on the in-lieu mitigation fee.

Project	Consumer Surplus ($/person/visit)	Project Lifetime (years)	Beach Width (feet)	Beach Lifetime (years)	Lost Recreation Value ($)	Net Present Value[1] ($)
Las Brisas	6.81	22	7.0	5	284,000	207,000
			14	10	325,000	236,000
			30.8	22	365,000	260,000
OHH	13.00	50	85	50	5,300,000	2,150,000
			8.5	5	1,200,000	600,000

1) Based on a 3% discount rate and project lifetime

Table 4.17 The impact of beach width on in-lieu mitigation fee.

Project	Erosion Rate (ft/yr)	Annual Beach Loss (ft^2/yr)	Beach Lifetime (years)	Lost Recreation Value ($)	Net Present Value[1] ($)
Las Brisas	1.4	32.5[2]	5	284,000	207,000
	0.14	3.25	57	244,000	180,000
	0.70	16.3	11	281,000	205,000
	2.8	65	3	298,000	220,000
OHH	1.7	870[3]	50	5,300,000	2,650,000
	0.17	87	500	530,000	26,500
	0.85	435	100	2,650,000	1,080,000
	3.4	1740	25	7,880,000	2,700,000

1) Based on a 3% discount rate and project lifetime
2) Values used in the CCC permit process for Las Brisas
3) Values used in the CCC permit process for OHH

Table 4.18 The impact of erosion rate on the in-lieu mitigation fee.

Figure 4.1 Shoreline armoring structures: a rock revetment in San Clemente, CA and a seawall in Monterey, CA. Source: Surfrider Foundation.

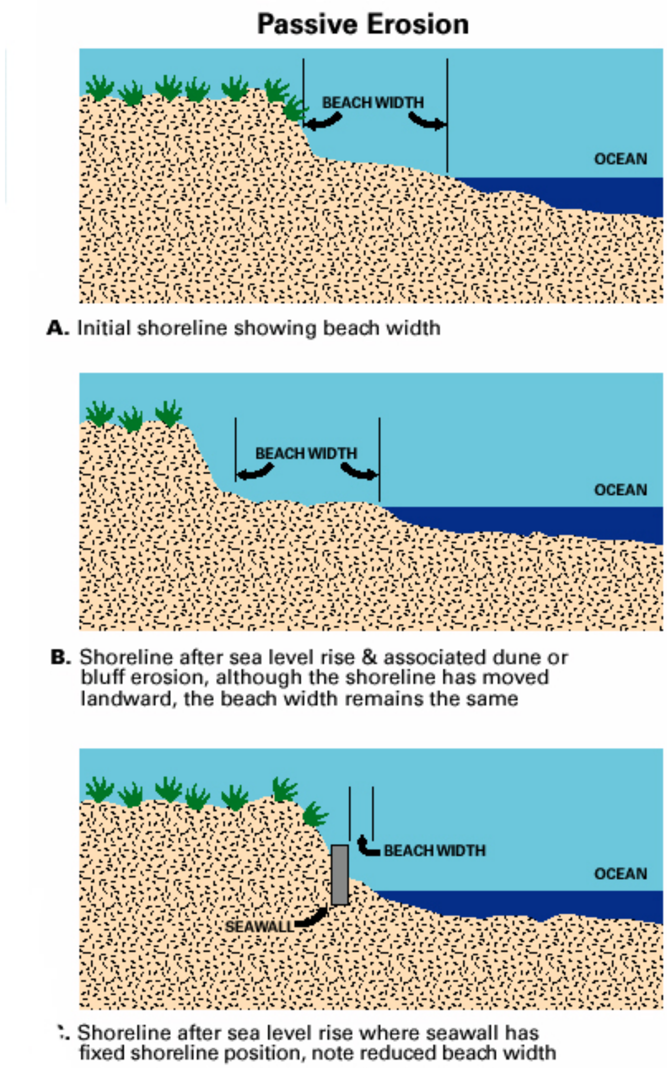

Figure 4.2 Passive erosion resulting from shoreline armoring. Source: Surfrider Foundation, based on Pilkey and Dixon (1996).

CEQA Mitigation Steps

1) Avoid the impact altogether by not taking a certain action or parts of an action.

2) Minimize impact by limiting the degree or magnitude of the action and its implementation.

3) Rectify the impact by repairing, rehabilitating, or restoring the impacted environment.

4) Reduce or eliminating the impact over time by preservation and maintenance operations during the life of the action.

5) Compensate for the impact by replacing or providing substitute resources or environments.

Figure 4.3 Hierarchical steps for mitigation based on Section 15370 of the CEQA guidelines.

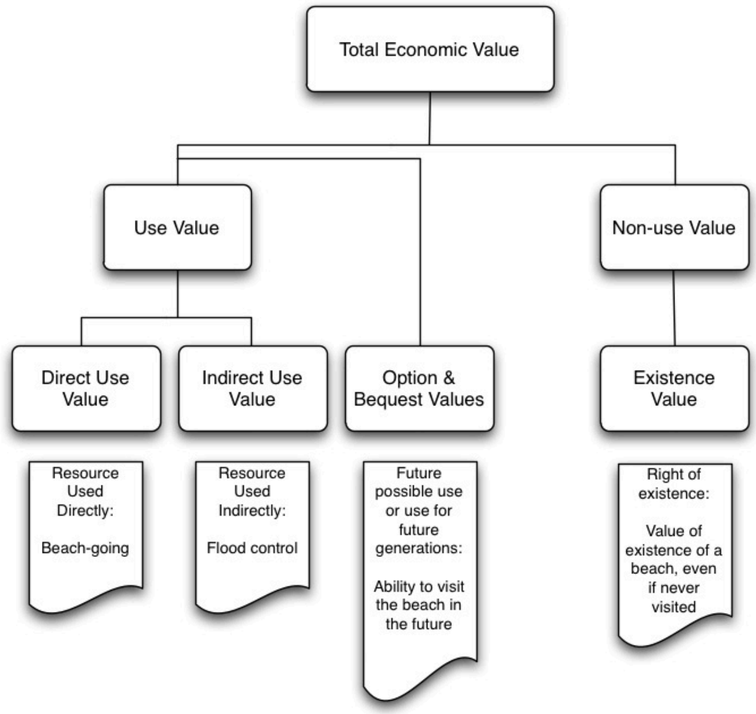

Figure 4.4 The total economic value of ecosystem services provided by sandy beaches.

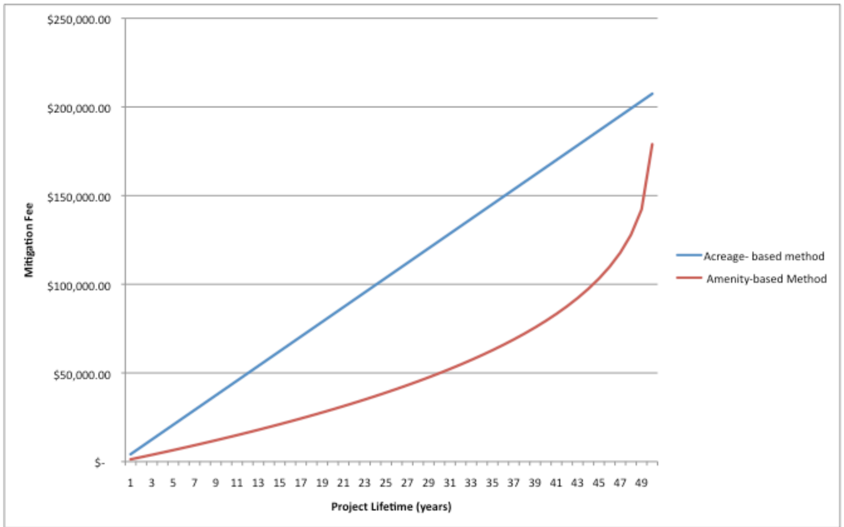

Figure 4.5 The area-based method and amenity-based methods for annual recreational value of the beach at Ocean Harbor House.

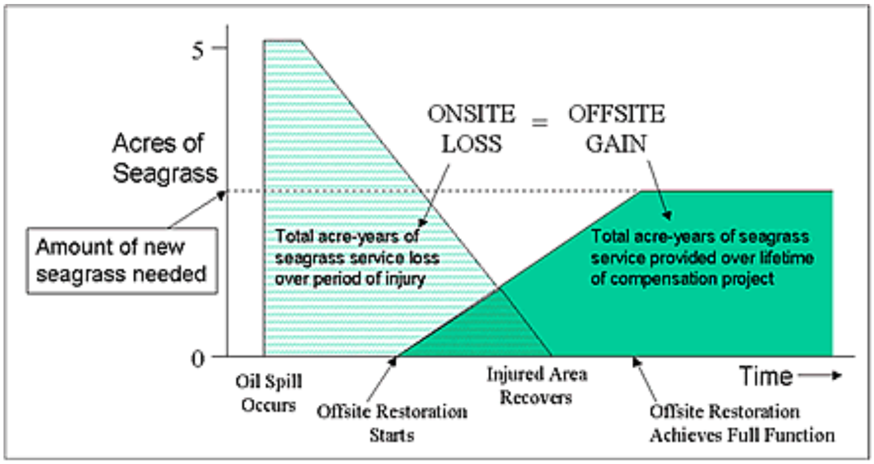

Figure 4.6 Example of HEA approach to scale offsite mitigation (CSC 2001).

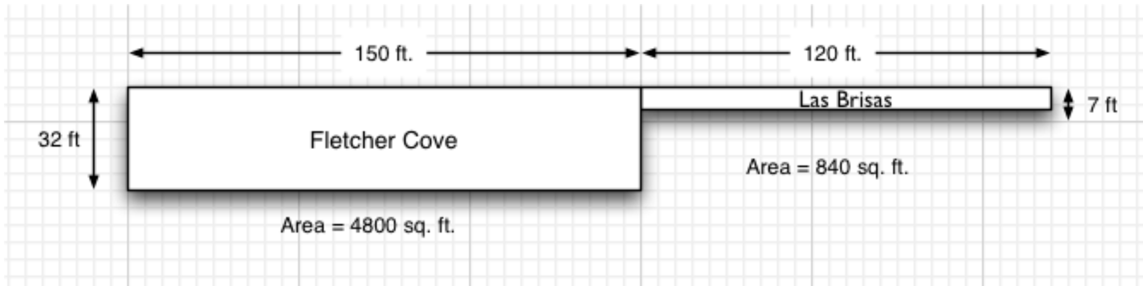

Figure 4.7 Configuration of beaches at Las Brisas and Fletcher Cove.

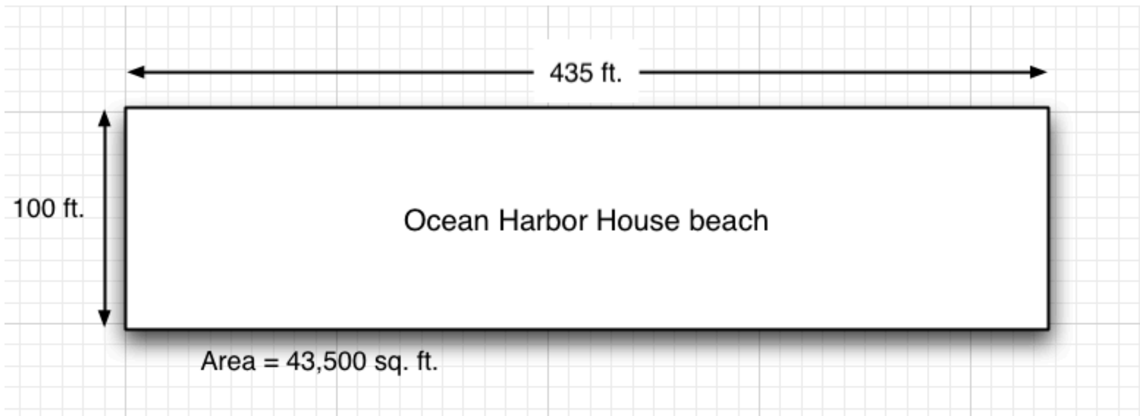

Figure 4.8 Configuration of beach at Ocean Harbor House.

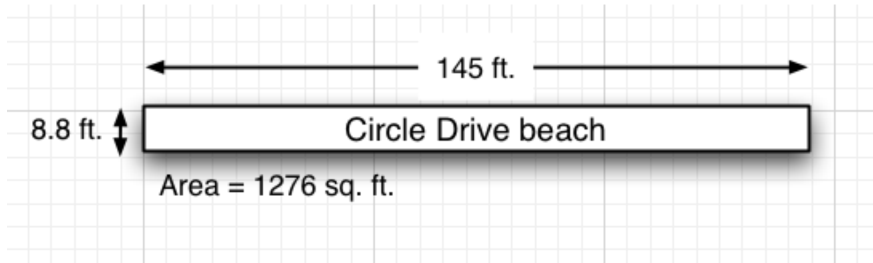

Figure 4.10 Configuration of beach at 629-633 Circle Drive.

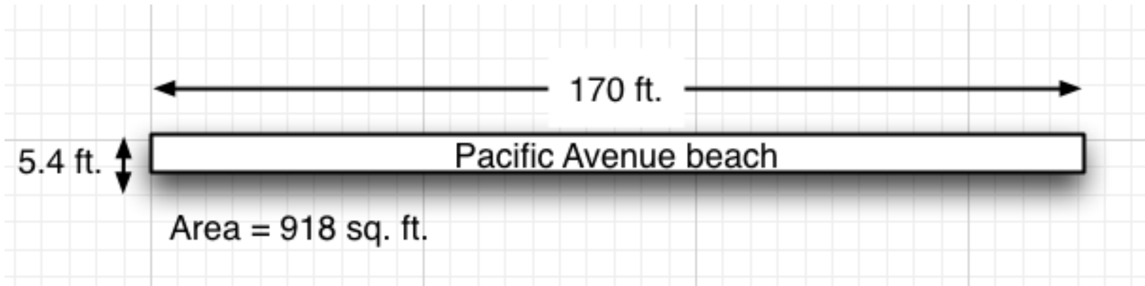

Figure 4.11 Configuration of beach at 417-423 Pacific Avenue.

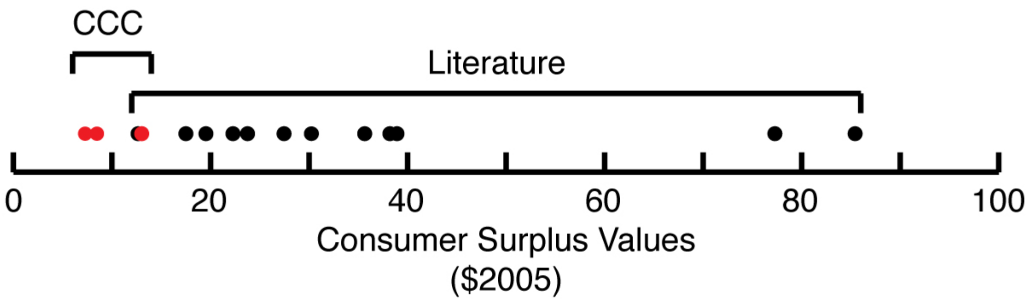

Figure 4.12 A comparison of consumer surplus values in the literature with those used by the Coastal Commission.

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Chapter 5

Conclusions

In California, and elsewhere, decision makers are forced to make difficult decisions on coastal issues in order to balance conservation and development interests. These decisions are often driven by economic arguments. Arguments for development can use known market forces such as the value of their development, increased tax review and the creation of jobs. These decisions result in trade-offs that impact the coastal environment, and the flow of recreational and ecosystem services that are supported by a healthy and accessible coastline. The economic impacts of coastal tourism are well known and are one of the most important drivers of the coastal economy in California and elsewhere (Kildow and Colgan 2005). Like other open access public resources, much of the economic value of coasts and oceans lies outside of traditional markets and less is known about the non-market values of coastal recreation or how coastal management decisions will impact these values. Information that accounts for both the market and non-market values associated with coastal conservation and recreation are required to make decisions regarding public resources that are best for the welfare of the public.

Research on non-market valuation has evolved over the last 30 years. There is a growing body of research on coastal recreation, but most of it is centered on beach going (Atiyah 2009). Coastal recreation is a diverse set of activities that include beach going, surfing, walking, swimming, shore fishing, kayaking, snorkeling, diving and many other niche uses. Most research on the economics of coastal recreation has grouped all of these participants as beach goers. However, these groups make choices regarding their recreation based on different beach attributes, have distinct behavior patterns, and different economic impacts and values associated with their recreational choices. See Nelsen, Pendleton et al. (2007) and Chapter 2 for an example regarding surfing. As a result, management decisions affecting coastal resources will impact these users differently.

Methods to better understand coastal recreation and determine the non-market values require the capture of data on the visitation and behavioral patterns, demographics and spending habits of coastal recreation by interviewing individual users either on-site or offsite (Haab and McConnell 2002). Compared to the large category of general beach goers, many of these niche activities attract a small population of highly avid visitors (e.g. scuba diving, surfing, standup paddle boarders) that represent a disproportionately high number of visits, local spending and non-market values for the size of the user group.

In some cases entire users groups may be missed when assessing the value of coastal recreation or not studied at all, which is the case with most niche uses. This can occur because the subset of users is too small to be captured via traditional population-wide surveys (e.g., phone or mail) or they use the coast differently than typical beach goers (different times, locations and seasons) and are missed by on-site surveys (Chapman and Hanneman 2001; Nelsen, Pendleton et al. 2007). To adequately intercept a sufficient number of respondents of these activities requires that there is a large number of survey respondents in a randomly chosen sample pool or that targeted methods are used to identify potential respondents from these groups.

In these circumstances, coastal zone managers are faced with a trade-off between developing a survey methodology that captures a large, random population of users that is representative but may not capture important niche uses (i.e., surfing) or developing a targeted survey (e.g., opt-in Internet-based survey instrument) that may not be perfectly representative but will still capture important recreational, demographic and economic data that can aid decision making. When weighing potential advantages and disadvantages of Internet-based surveys, it is not the degree to which the survey is perfectly representative, but how those disadvantages compare to other alternatives (e.g., other survey methods or no data at all) or if information collected will address the management questions that the information is designed to answer.

Traditional survey modes such as Intercept surveys, Random Digital Dialing (RDD) or mail-back survey instruments are more widely accepted and well vetted in the academic literature and provide the ability for extrapolate to the larger population (Dillman, Smyth et al. 2009). They also have disadvantages. They are expensive and time consuming to implement, especially when considering large areas with numerous access points. They may require a prohibitively large sample size to capture small but avid users groups or capture a sub-sample too small to provide statistically robust results.

Internet-based survey modes also have clear advantages and disadvantages. Internet-bases surveys used for economic valuation are not yet common in the literature and therefore less accepted by academics or agencies. They often suffer from lack of repetitiveness because the survey frame is not known and therefore cannot be extrapolated to the larger population of users (Couper 2000). Internet-based surveys may also be biased because the demographics of Internet users may be different than the general population.

Despite these disadvantages, the detailed information provided from Internet-based survey instruments may still answer important questions that can aid coastal zone decision-making. For example, Internet-based survey methods can aid in revealing the spatial extent of specialized coastal uses. In turn, this data could be used to identify specific locations for intercept surveys. Internet-based surveys can also provide targeted demographic and economic information on the users captured, which has value even if not expanded to a larger population. Further, Internet-based surveys may provide insights and raise question that motivate further research using expanded Internet-based research (e.g., representative Internet panels) or traditional methods.

For example, two previous decisions that affected surfing resources did not benefit from empirical research on the consumer surplus values of surfing, likely because surfers are difficult to survey. Surfers are hard to capture because their population of surfers is relatively small, their distribution is clustered, and they can be difficult to intercept (Nelsen, Pendleton et. al. 2007). In 1990, the American Trader oil spill closed access to popular beaches and surfing areas in Huntington Beach, California. It was possible to transfer empirical consumer surplus values from previous studies to determine the appropriate mitigation fee for the lost value for beach going, but surfing proved more difficult. Although surfer visits were counted using extended survey hours to capture their use (6:30 a.m. to 6:30 p.m.), surfers were not intercepted or surveyed to determine the consumer surplus of surfing. Instead, the consumer surplus of a surf visit was first estimated as equivalent to a nearby water park ($16.95 in 1990 dollars) and then later as 25 percent higher than an individual beach visit ($18.75 in 1990 dollars) (Chapman and Hanneman 2001). Neither of these values was based on empirical data. Second, when seeking mitigation for impacts to a popular surfing area in El Segundo that was degraded by the construction of a groin and beach fill, the Coastal Commission referred to Chapman and Hanneman's (2001) water park entrance fee to value surfing when determining the lost consumer surplus. In both cases, the consumer surplus values of surfing was likely undervalued due to lack of research on the economic values associated with surfing.

In contrast, when the Coastal Commission was considering a toll road project that could impact surfing at Trestles, in San Onofre State Park, an Internet-based survey was used to quickly and inexpensively gather data on surfers visiting Trestles to show that Trestles is used by an relatively small (compared to beach goers) group of highly avid surfers who are willing to travel long distances and generate annual economic impacts to the City of San Clemente ranging from $8-12 million [$2006] (Nelsen, Pendleton et al. 2007). In this case, the non-market values of surfing at Trestles that are discussed in chapters 2 and 3 were not included because that research had not been completed. Inclusion of the consumer surplus values would have provided more insight into the value of surfing at Trestles during the decision making process. The results on economic impacts, not economics values, were provided to the California Coastal Commission and were considered during their consistency determination regarding the construction of a toll road that would likely impact the quality of the waves at Trestles. In this case, the economic impacts associated with the surfing resource at Trestles were considered in the decision making process and played a role in the denial of the project (CCC 2007).

In other circumstances, decision makers face tight permitting deadlines and lack the resources and expertise to conduct original economic research. In these cases, the best available existing research must be used to make decisions. Even when studies are available for use, coastal managers often lack the expertise to develop economic valuations consistently and based on accepted practices in the literature so that their estimations will stand up to academic or legal scrutiny.

The Coastal Commission's efforts to estimate in-lieu mitigation fees for the adverse impact of shoreline armoring on beaches, subject of Chapter 4, is a clear example. For each permit where a shoreline protective device is permitted, the Coastal Commission must estimate the consumer surplus of a beach visit, estimate the loss of consumer surplus as the beach erodes and narrows over the lifetime of the project, and also consider values for lost non-recreational ecosystem services. Although consumer surplus values for beach going are well studied, the Coastal Commission has not accurately and consistently used benefit transfer methods to estimate the consumer surplus and as a result consumer surplus estimates for a beach visit are consistently lower than those found in the literature (Figure 4.12).

The Coastal Commission has applied inconsistent models to estimate the loss of consumer surplus on an eroding beach. Pendleton, Mohn et al. (2011) provide the only empirically-based model, using a RUM, to show that consumer surplus and attendance are lost as beaches narrow. The direct application of Pendelton, Mohn et al (2011) to individual shoreline armoring permits is limited because it is too complex, expensive and time consuming. As a practical matter the Coastal Commission is limited to applying simple models such as the area-based or the amenity-based models. However, the legal case at the Ocean Harbor House shows that a reasonable model can withstand legal scrutiny (OHH 2008). King's (2006) amenity-weighted model, improved upon in Chapter 4, provides a reasonable and consistent method to transfer benefits from a study site to a policy site and estimate lost recreational value as the beach narrows if additional study was conducted to empirically value and weight beach amenities. It is recommended that this model be standardized through the development of a procedural guidance document (PGD). This approach has proven successful for the Coastal Commission to determine the value of sand impounded by shoreline armoring. This approach could be extended to include procedural guidance on benefit transfer and modeling consumer surplus lost on beaches adversely impacted by shoreline protective devices.

The lack of research on beach ecosystems and their values limits the Coastal Commission's ability to estimate values for non-recreational ecosystem services and provides a clear need for additional research on characterizing beach ecosystem services and the values associated with them. That said, the Coastal Commission has not consistently acknowledged that its mitigation estimates have been conservative because all beach ecosystem services are accounted for. The conceptual model of beach ecosystem services provided in Chapter 4 provides a framework to better understand which values are being captured and which services are being assigned zero value. Following this conceptual model would add consistency to the approach used by the Coastal Commission and make explicit those values that are not being considered.

The use of non-market values for beach recreation by coastal zone decision makers would benefit from additional research in a few key areas. First, additional economic research and valuation on niche coastal recreational activities would enable the decision makers to better understand how a decision may affect different types of coastal uses and also better value those uses for decision making or mitigation. Additional research using representative and opt-in Internet-based surveys will also aid our understanding of the value and drawbacks these survey instruments provide to reach these difficult to survey groups. Research is needed on beach ecosystems and their values in order to establish a baseline for ecosystem service conditions and how those services change when beaches are affected by erosion will aid not only valuations using demand-based consumer surplus methods but could also provide the baseline information necessary to apply a supply-based approach, such as the Habitat Equivalency Analysis.

Everyday coastal zone managers are making decisions that impact the coastal ecosystems that are used for recreation. Many of these decisions have economic information on the benefits of coastal development, but few have information on the non-market economics of coastal recreation. In California, efforts by the Coastal Commission lack non-market values of coastal resources and recreation, which has the effect of tilting decision making towards the benefits of development instead of toward conservation of public resources. This is shown in cases in California involving surfing (e.g., Pratte's Reef and the American Trader Oil Spill), the adverse affects of shoreline armoring on beach going and the lack of valuation for beach ecosystems.

Coastal management decision makers lack economic experience compared to planning, policy, physical science and legal expertise. Additional research on the economics of coastal recreation and, more importantly, academic work that provides practical tools for coastal decision makers will provide a more level playing field when making trade-offs between conservation and development of coastal resources. Most importantly, improved understanding of non-market values associated with the coast will help ensure that public coastal resources do not continue to be undervalued in decision making in the future.

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