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Measuring the effects of stormwater mitigation on beach attendance

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ABSTRACT

Many studies have used valuation techniques to predict the potential effect of environmental improvements on human use of coastal areas, but there is a lack of post hoc empirical evidence that these policies indeed affect the way people use coastal areas. A panel data approach is developed to statistically determine how storm drain diversions affected attendance at 26 beaches in Southern California. This study uses a 10-year time series of data to conduct a statistical analysis of attendance at beaches with and without diversions and before and after the diversions were installed, while controlling for all observable, confounding factors. Results indicate that beach attendance increased at beaches with diversions compared to those that did not have diversions (between 350,000 and 860,000 visits annually at a 95% confidence interval). Establishing this link between mitigation policies and human use patterns can lead to better management of coastal areas.

1. Introduction

It is often claimed that cleaning up the environment is not just good for the environment, but good for people too. Previous studies have been conducted to estimate the value of coasts and their ecosystems, including studies that estimate the potential economic value of coastal mitigation (Hilger and Hanemann, 2006; Lew and Larson, 2005; Jeon et al., 2005; Hanemann et al., 2004; Hanley et al., 2003; Freeman, 1995; Silberman and Klock, 1988; Bockstael et al., 1987). They typically contain some value for the human use of the coast. Clearly, the use value of this resource should increase with the intensity of its use. Surprisingly, though, the studies do not show empirically that improvements in the environmental quality of coastal areas have had a statistically discernible effect, over time, on their human use.

This paper examines whether policies, such as the installation of storm drain diversions, do impact human use of beaches and how this impact can be expressed in measurable terms. Data routinely collected by a variety of agencies—including data on beach attendance, environmental conditions, and other variables—are used to analyze beach-going trends over a period of time and across several sites in Southern California. Using beach attendance as an indicator, the study shows empirically how the implementation of storm drain diversions has influenced human use of beaches in a statistically significant manner. While not designed for this kind of analysis, the data can easily be tailored for this purpose. The strength of the results shows the potential value of collecting better-integrated indicator data on human uses and ecosystem conditions for coastal areas.

1.1. Using indicators to measure human uses of coastal areas

An important challenge for those involved in coastal management is to show that pollution mitigation activities are accomplishing their intended goals. In order to do this, coastal managers need to be able to measure the progress, effectiveness and specifically the impacts of coastal mitigation on humans. Coastal management scholars and professionals use variations on a basic model known as the Pressure-State-Impact-Response (PSIR) model to understand and account for the links between people and activities (Bowen and Riley, 2003; OECD, 1993). While the PSIR model is too simplistic to serve as a purely behavioral model of coastal users, it does provide a conceptual accounting that links the pressures of human population growth to changes in the state of the marine environment to changes in human activities. For instance, human wastewater (a pressure) may change bacterial levels at a beach (a state) that in turn adversely impacts swimming and causes gastro-intestinal illnesses among swimmers (the impacts). In response, efforts might be undertaken by the local health authorities to reduce bacterial impacts through the treatment and control of wastewater.

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Beyond providing a conceptual framework for understanding the way people and the environment interact, the core framework of the PSIR model serves as a guide for collecting data to model and predict how changes in human behavior affect the environment and how these environmental changes in turn affect human behavior. Towards that end, great progress has been made in collecting data to characterize and monitor change in the state of coastal ecosystems. Ecological indicators are in place to measure levels of nutrients, bacterial contamination, turbidity, salinity, and several other dimensions that help to characterize coastal ecosystems. Far less effort has been invested in developing measures of human impact, response and activity.

Recognizing the need to measure and monitor both the ecological and socio-economic outcomes of coastal and marine restoration and management, a number of scholars and organizations have embarked on attempts to design and collect data on integrated ecological and socio-economic indicators of coastal management (Bowen and Riley, 2003; Ehler, 2003; Belfiore, 2003). The Organization for Economic Cooperation and Development and the European Union, among others, have developed frameworks for the collection of integrated coastal and marine indicators (European Commission, 2002; OECD, 2000). The United States' National Oceanic and Atmospheric Administration's Coastal Restoration Center has also developed a framework for measuring the human dimensions of coastal restoration (Salz and Loomis, 2005).

One goal of indicator development is to identify data that can be easily and accurately collected over time, while still accurately measuring the impacts of interest to policy. A good indicator should reduce the total number of measures that need to be collected, which normally would be required for an exact representation of a situation. The indicator should be able to act as an instrument to measure the impact of policy changes, while ignoring the effect of external confounding factors. Further, indicators should simplify the process of communication to managers, stakeholders, and communities and should represent dynamic parts of an overall portrait that is understandable and compelling to its intended user community (Vandermeulen, 1998). Salz and Loomis (2005) provide a discussion of proposed indicators specifically designed to measure human uses of coastal systems. While this discussion examines human use indicators in the context of ecological indicators, it does not provide specific guidance on how to analyze these indicators to show the impact of coastal mitigation on human uses.

2. Establishing indicators for recreational beach use

While indicators have been developed to monitor the condition of marine and coastal environments (e.g. fecal bacteria, nutrient loads, dissolved oxygen), far less has been done to show how changes in coastal ecosystem indicators and conditions are related to measurable changes in human uses. For example, even if an environmental indicator shows that a policy action resulted in improvements to marine/coastal ecosystems, there often are insufficient data to show that these improvements have yielded measurable changes in the way people use these ecosystems (Pendleton, 2007). The biggest obstacle to empirically demonstrating the effect of policy action and ecosystem change on human uses is the lack of good, consistent data on human uses of coastal areas. In order to identify a statistically significant effect from a given policy change on people, it is important to collect data on human uses both before and after a policy intervention in similar areas and with and without the policy intervention. Comparing observably similar areas before and after a policy change in only one of the two areas allows the impact of the policy change to be isolated from otherwise unrelated changes that have occurred due to the passage of time. This approach is commonly known as the difference in differences or DiD approach.

Since beach attendance is already available and widely collected in the Santa Monica Bay region of Southern California, attendance is used here as an indicator of the human use of beaches. When beach attendance shifts, up or down, this measurable change may indicate a response to an environmental condition resulting from some policy action. The presence or absence of a storm drain diversion may have many observable, visible or otherwise, impacts on the quality of a beachgoer's experience at a beach (i.e. more or less litter from surface runoff accumulating along the coast). If the quality of the beach-going experience declines sufficiently, then beachgoers on the margin of making an alternative choice for their recreation will substitute other activities, causing beach attendance to decrease. If the quality of the beach-going experience improves, then beach attendance would increase. Thus the impact of coastal storm drain diversions can be measured via the indicator variable of beach attendance at those beaches.

3. Description of the site and data

The study site is Santa Monica Bay (SMB) in Southern California, an area consisting of 50 miles of coastline. The Bay's sandy beaches are heavily used as a recreational resource by tourists, as well as residents of Los Angeles and Ventura Counties. A few beaches in Malibu, located just outside SMB, were also included, as they are geographically close and managed by the same county agencies. On any given year, between 50 and 60 million visits are made to beaches in the Santa Monica Bay area and the nearby beaches of north Los Angeles County (Dwight et al., 2007). As the site of a national estuary program, SMB beaches and their waters have been closely monitored and managed by numerous environmental groups (e.g. Heal the Bay, Santa Monica Bay Restoration Commission, United States Environmental Protection Agency, Santa Monica Bay Keeper)

3.1. Dependent variable: Beach attendance data

In this study, panel data—data collected at many sites over several years—on beach attendance was used as an indicator of beach use. Attendance data were provided by the Los Angeles County Fire Department's Lifeguard Division (LACOFD) and include annual attendance figures (number of visits per beach per year) for 26 public beaches in SMB over a period from 1996 to 2006. LACOFD collects attendance data daily (twice a day) by lifeguards through direct observation. Table 1 contains a list of all the public beaches examined in this study. Because data for several sites over a 10-year period is available, beach attendance can be examined at sites with and without a policy intervention (e.g. storm drain diversion). Further, the time series nature of this panel of data provides an added dimension not found in studies using only a single year of

Table 1
List of 26 Santa Monica Bay study sites/beaches.

Nicholas	Marina Del Rey
Zuma	Scattergood
Point Dume	El Porto
Corral	Manhattan State
Malibu	Hermosa
Las Tunas	Redondo County
Topanga	Avenue C
Will Rogers (North and South)[a]	Torrance
Santa Monica (North and South)[a]	Abalone Cove
Venice (North and South)[a]	White Point
Dockweiler (North and South)[a]	Cabrillo

[a] Lifeguard division maps were used to delineate North and South boundaries.