Available online at www.sciencedirect.com
ScienceDirect
Ocean & Coastal Management
ELSEVIER
Ocean & Coastal Management 50 (2007) 847–858
www.elsevier.com/locate/ocecoaman

Beach attendance and bathing rates for Southern California beaches

Ryan H. Dwight[a,*], Mitchell V. Brinks[b], Gajapathi SharavanaKumar[b], Jan C. Semenza[b]

[a]*Coastal Water Research Group, Huntington Beach, CA*
[b]*School of Community Health, Portland State University, OR, USA*

Available online 27 April 2007

Abstract

Annual beach attendance (BA) was collected for 75 beaches along the 350 km of coastline in Southern California for the years 2000–2004. On average, over 129 million beach visits occur each year, with the majority (54%) of visits occurring at only 15 beaches. Almost half of all visits (48%) occur on weekends. BA displays distinct seasonality with 53% of visits occurring in June, July and August. On average only 45% of individuals attending the beach have physical contact with the coastal waters; water exposure rates are low (26%) during colder winter months, and peak during warmer summer months (54%). An average of 56 million recreational bathing events (BE) occurs in Southern California's coastal waters every year. This quantification and statistical analysis of the magnitude and distribution of beach visitations across the region produce important data that have direct implications for beach management, tourism, public health and the environment.

1. Introduction

The beaches of Southern California are world-renowned recreational destinations that attract millions of visitors annually and are a major contributor to the regional economy [1,2]. A recent study of California's Ocean Economics quantified tourism and recreation as generating 79% of ocean-related employment [3]. When describing the gross state product produced by Ocean Economics, the report found 59% of the money came from tourism and recreation. While areas such as construction, living resources, minerals and ship

*Corresponding author. Tel.: +949 500 5276; fax: +949 266 8680.
E-mail address: admin@coastalwaterresearch.com (R.H. Dwight).

0964-5691/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.ocecoaman.2007.04.002

building may receive public attention, their overall contribution to California's Ocean Economy is relatively small accounting for 7.5% combined. California's Ocean Economy is the largest in the United States, and Southern California generates more than half of the State's total market value in excess of $24 billion annually. However, there has been no detailed quantification or analysis of the number of visitors utilizing the vital beach resources. A better understanding of the recreational use patterns of these beaches is necessary for effective beach management, economic development and efforts to address public health and environmental concerns.

General annual beach attendance (BA) values have been generated in a few reports, but unfortunately, these crude estimates do not reflect the temporal and geographic variation inherent in these events. Greater detail in the distribution and magnitude of beach visitations allow for more appropriate decision making. The US Lifesaving Association collects and reports visits to many beaches across the country, with 123 million beach visits reported for the Southern California region in 2005 alone [4]. In a commissioned report on the economic value of California's coastal areas, researchers reported an average of 100 million annual beach visits to Southern California beaches [1]. In another report, researchers estimate Southern California annual BA to equal 151 million visits [5].

In addition to quantifying the number of beach visitors, it is also important to understand the number of beach visitors who recreate in the coastal waters. The majority of beach visitors do not swim in the coastal waters, enjoying their visit in other ways. An investigation conducted in Newport and Huntington Beaches in Orange County estimated that only 27% of beach visitors enter the water during the warmer season between April and September. This value decreases to 18% between October and March [6]. Another report estimated bathing rates (BR) of beach visitors to range between 43% in the summer months down to 9.56% in February [7]. These results were generated by a random sample phone survey, and not through direct observations of beach visitors. Another study reported a mean annual bathing rate for California of 47%; this result too was generated by a random sample phone survey [5,8].

In order to advance the field with a comprehensive and quantitative assessment of recreational water use for the entire coastal region of Southern California, a study investigator visited all agencies and beach locations in charge of BA. Five years (2000–2004) of data for 75 beaches were collected and analyzed. This is the most comprehensive study to date and provides objective measures of the magnitude and temporal/geographic variation of recreational marine water use in Southern California.

2. Methods

2.1. Beach attendance

All agencies responsible for collecting BA data along the 350 km coast of Southern California were systematically contacted by a study investigator. Data from all major beaches in Los Angeles, Orange and San Diego Counties were recorded manually or electronically for 1824 days from January 2000 to December 2004 and compiled in an Excel spread sheet. 134,125 daily BA values were subjected to mathematical modeling. Data were compiled from records at lifeguard agencies (76%), parks departments (16%) and environmental health departments (8%). Data were derived from

direct observation (73%), from parking, hotel and camping receipts (19%) and from electronic counters (8%).

A beach was defined as any coastal shoreline area recognized as such by a supervising governmental agency (75 beaches met this inclusion criteria). Some beach areas were broken down into several small beaches, such as in Mission Bay and Encinitas, both in San Diego County. The data for these few beaches areas were combined and reported as single beach locations. For some other areas, there were several small beaches that were well defined, but due to low attendance levels, the monitoring agencies combined attendance data into a single value. Combining data for multiple beaches only changes the unit of analysis and does not alter numeric results.

Cubic spline interpolation [9] was used to estimate missing values for short periods (<6 days) of missing data (4% of values). This method of interpolation approximates the generally smooth and continuous seasonal and daily fluctuations in attendance levels evident throughout the study period. Longer periods of missing data (18%) were estimated using regression from the nearest beach that had a regression value of >0.6 during periods when attendance at both beaches was available. The rate of correlation between adjacent beaches was highly significant.

Southern California has several beaches located in bays and harbors keeping them sheltered from the open ocean. These beaches are popular for families with small children because there are no hazardous waves or currents. Unfortunately, two of the larger recreational bay areas do not record attendance data, and two others only report summertime data (which is when the majority of beach usage occurs). This lack of data will cause a modest underestimation in the total values generated. There are also several smaller beaches along the vast Southern California coastline that are not under the surveillance of lifeguards or other monitoring agencies. The lack of data for these smaller beaches will also result in a more conservative estimate of total BA.

2.2. *Bathing rates*

Bathing rates (BR) were derived from long-term data sets produced independently at Del Mar and Oceanside Beaches, two San Diego County beaches where lifeguards estimated the number of beach visitors, as well as the number of people who entered the water. Bathers are defined as individuals actively engaged in water-contact recreation such as swimming and surfing. The daily Oceanside beach data set from 2001 to 2004 had few missing data points (3.4%), the Del Mar Beach data set from 2002 through 2004 had 28% missing data points. Data from the two beaches were significantly correlated ($P<0.01$); therefore, the monthly averages were generated by combining both data sets ($n = 2192$ total days). The daily BR values were used to calculate the mean BR per month.

We make the assumption that the multi-year BR recorded daily at two individual San Diego County beaches is applicable to all the beaches in the study area. This assumption of uniformity is supported by the distinct seasonal pattern of BA being observed at all beaches. Further, meteorological conditions greatly influence BR (as well as BA) and the climatic patterns and coastal water temperatures are similar across these three contiguous coastal Counties. The vast majority of the beaches along the Southern California coastline are similarly open, white sand beaches with varying levels of amenities, and thus Oceanside and Del Mar beaches are appropriate representative beaches for the Southern California region.

2.3. Bathing events

The number of bathing events (BE) per beach was calculated by applying the BR per month (percentage of beach visitors who swim) to each day's BA per beach

$$\text{Equation : } BE = (BA)(BR)$$

(BE = bathing events; BA = beach attendance; BR = bathing rate).

In calculating BE, we excluded attendance values from BA that represent a population unlikely to swim, such as those at adjacent parks, piers and boardwalks. These data were included in the annual BA values to accurately represent total number of visitors, but was removed for the analysis of BE, as to not over-estimate exposure events. From 2000 to 2004, a total of 14,442,567 beach visitors were subtracted from the calculation of BE; roughly 2.9 million visits per year.

3. Results

3.1. Beach attendance by day

BA demonstrated dramatic increases on weekends when compared to work days of the week (Fig. 1), with almost half of all beach visits (48%) occurring on Saturdays and Sundays. Holidays also showed large increases in beach visitation. These temporal variations are accounted for in our analysis and calculations because we used attendance data at the daily level.

3.2. Beach attendance by season

BA patterns show large variations between seasons with more than half (53%) of all visits occurring during the three summer months (Fig. 2). The distribution followed a seasonal sinusoidal curve. This smooth attendance pattern was consistent across years as well across beach locations.

3.3. Beach attendance by year

Integration of BA for each year did not reveal significant deviation from the mean over the 5 years studied. Southern California experienced a wide range of general weather patterns during the study period with high levels of rainfall one year and drought in another. Regardless of the large variations in winter weather, annual attendance rates remained relatively stable since the majority of visits occur during the summer months, which were consistently warm and dry. However, from 2000 to 2004, there was a slight 5% increase in annual attendance for Southern California beaches. This trend may result from general population growth in the region, or from standard deviation in the data.

Data analysis revealed an annual mean of 129 million beach visits in Southern California (Table 1). This does not represent 129 million individual people going to the beach, but rather the total number of visits that occur per year. The number of individual beach visitors is lower because a portion of the values is generated by people, who frequently visit the beach throughout the year.

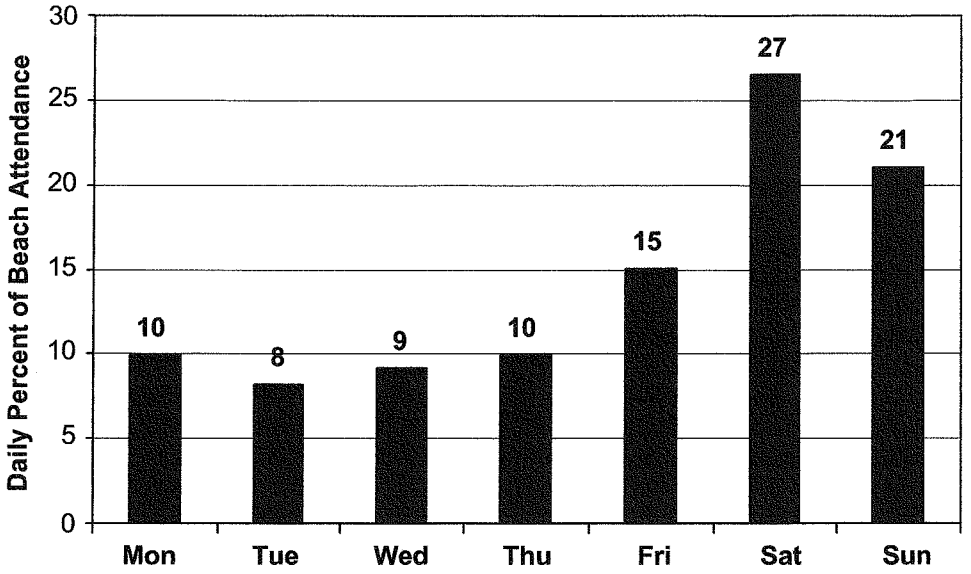

Fig. 1. Distribution of beach attendance by day of the week for Southern California beaches (2000–2004).

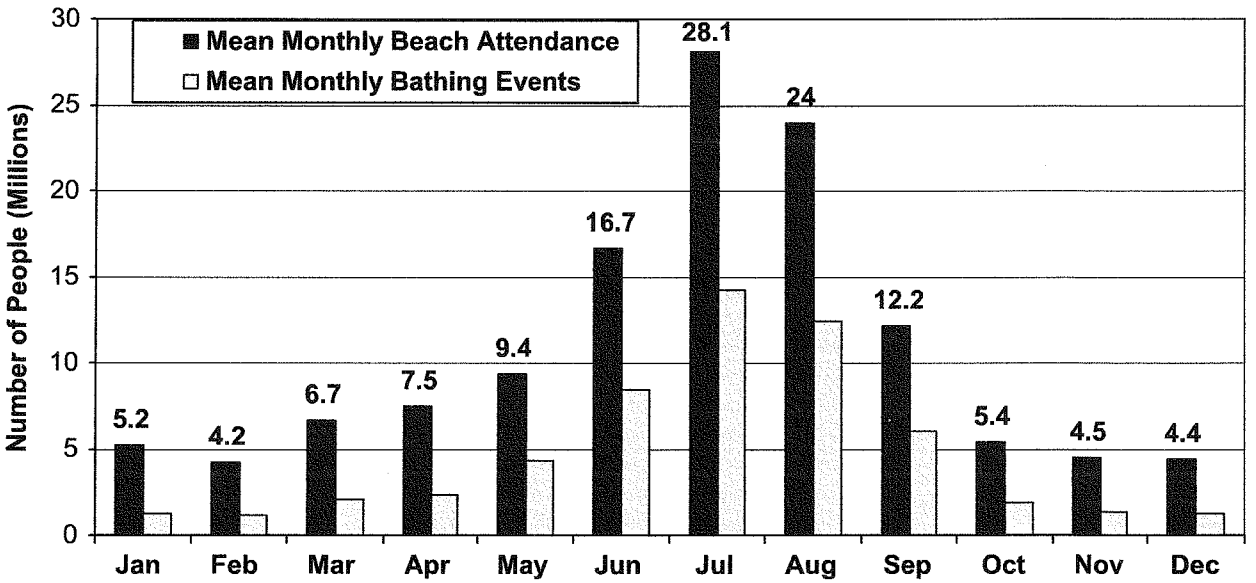

Fig. 2. Distribution of mean beach attendance and bathing events by month for Southern California beaches (2000–2004).

3.4. Beach attendance by location

The 129 million annual beach visits are disproportionately distributed along the coast with the majority occurring at a few beach locations; one-third of all attendance occurs at the top six beaches, and the majority (54%) occur at only 15 out of the 75 beaches investigated (Table 1, Fig. 3). Annually, 40% of all Southern California visits occur at Los Angeles beaches and the remaining visits are evenly distributed between Orange and San Diego Counties.

The Los Angeles County beaches with the highest attendance levels are Zuma (5.5% of total Southern California attendance), Santa Monica (3.7%), Venice (4.4%) and Long

Table 1
Mean annual beach attendance and annual bathing events at Southern California beaches (2000–2004)

	Beach	Avg. attendance	Avg. bathing events
Los Angeles County			
1	Nicholas Canyon	200,939	87,512
2	Robert Meyer	572,635	238,736
3	Zuma	7,060,397	3,418,831
4	Point Dume	1,097,965	502,781
5	Corral	281,301	132,156
6	Malibu Lagoon	1,649,174	755,371
7	Topanga	562,640	249,608
8	Will Rogers North	357,062	159,678
9	Will Rogers South	1,645,770	753,378
10	Santa Monica North	4,175,148	1,936,991
11	Santa Monica South	4,657,450	2,167,452
12	Venice North	5,636,961	2,592,990
13	Venice South	2,773,460	1,249,211
14	Marina Del Ray[a]	264,071	118,570
15	Dockweiler North	1,154,544	524,552
16	Dockweiler South	1,945,238	921,343
17	El Segundo	516,848	226,596
18	El Porto	1,468,813	656,250
19	Manhattan	1,165,681	532,318
20	Manhattan Pier	2,246,525	900,810
21	Hermosa	2,784,884	1,263,281
22	Redondo	2,406,484	1,073,001
23	Torrance	1,406,660	647,159
24	Abalone Cove	232,979	95,210
25	Whites Point	656,988	269,762
26	Cabrillo	1,126,306	497,208
27	Long beach	4,720,897	1,714,316
	Total: Los Angeles	**52,767,820**	**23,685,067**
Orange County			
28	Seal beach	651,917	275,040
29	Surfside	27,163	11,460
30	Sunset	769,722	355,694
31	Bolsa Chica	2,159,722	952,978
	Huntington harbor	No data	No data
32	Huntington beach	6,520,415	2,887,141
33	Huntington beach South	6,153,388	2,808,517
34	Newport beach	7,642,140	3,562,128
	Newport harbor	No data	No data
35	Corona Del Mar	676,585	315,356
36	Little Corona Del Mar	169,146	78,839
37	Crystal Cove	551,317	230,229
38	Emerald Bay	124,224	55,046
39	Laguna	3,544,917	1,510,996
40	Aliso	434,648	192,615
41	Camels	248,395	110,074
42	Table Rock	62,164	27,506
43	Thousand Steps	186,305	82,559
44	Three Arches	186,305	82,559
45	Salt Creek/Strand	1,611,061	711,754

Table 1 (*continued*)

	Beach	Avg. attendance	Avg. bathing events
46	Dana harbor/Baby	102,068	46,140
47	Doheny	1,681,520	713,726
48	Capistrano	331,739	149,957
49	Poche	76,581	34,614
50	San Clemente	2,009,468	884,011
51	San Clemente	735,044	316,974
	Total: Orange	**36,655,954**	**16,395,912**
San Diego County			
52	San Onofre	2,134,093	908,932
53	Oceanside	3,600,026	1,587,661
54	Carlsbad	1,475,721	591,819
55	South Carlsbad	1,480,664	632,497
56	Encinitas	2,936,325	1,167,458
57	San Elijo	782,996	314,839
58	Cardiff	1,449,819	610,926
59	Del Mar	1,806,303	768,895
60	Torrey Pines	635,847	249,219
61	Blacks	766,030	338,546
62	Scripps	345,908	175,289
63	La Jolla Shores	2,557,401	1,162,002
64	La Jolla Cove	733,833	188,459
65	Casa	1,323,010	394,292
66	Marine Street	148,206	76,692
67	Windandsea	1,420,487	539,317
68	North Pacific	1,512,818	666,687
69	South Pacific	2,902,424	1,256,841
70	Mission beach	5,138,661	2,176,426
71	Mission Bay[a]	849,608	437,276
72	Ocean	1,328,447	573,244
73	Coronado	2,034,266	867,635
74	Silver Strand	549,207	244,520
75	Imperial	1,931,760	737,871
	Total: San Diego	**39,843,860**	**16,667,343**
	Total: So. California	**129,267,634**	**56,748,323**

[a]Summer time data only.

Beach (3.2%). There are also relatively high attendance levels along the stretch of beaches that include Dockweiler (1.5%), El Porto (1.2%), Manhattan (0.9%), Hermosa (2.2%), Redondo (1.9%) and Torrance (1.1%) beaches. All of these beaches (with the exception of Zuma and Long Beach) are contiguous and are located inside the Santa Monica Bay. In Orange County, the beaches with the highest attendance levels are Huntington Municipal (5.1%), Huntington State (4.8%) and Newport (6.0%) beaches, which account for 55% of all beach visits in Orange County. These three beaches are also contiguous. BA is more evenly distributed along the coast in San Diego County, where only Mission Beach (3.8%) experienced attendance levels comparable to those seen at beaches in the other two counties.

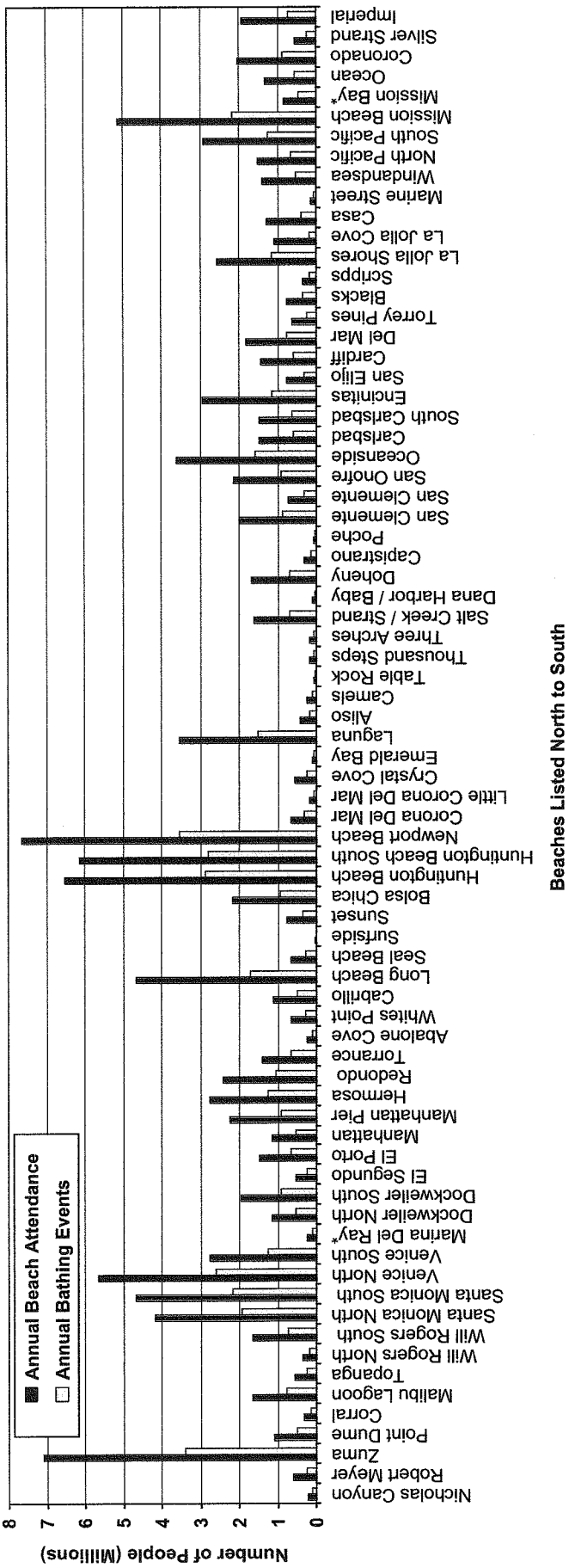

Fig. 3. Distribution of mean beach attendance and bathing events along the Southern California coastline (2000–2004).

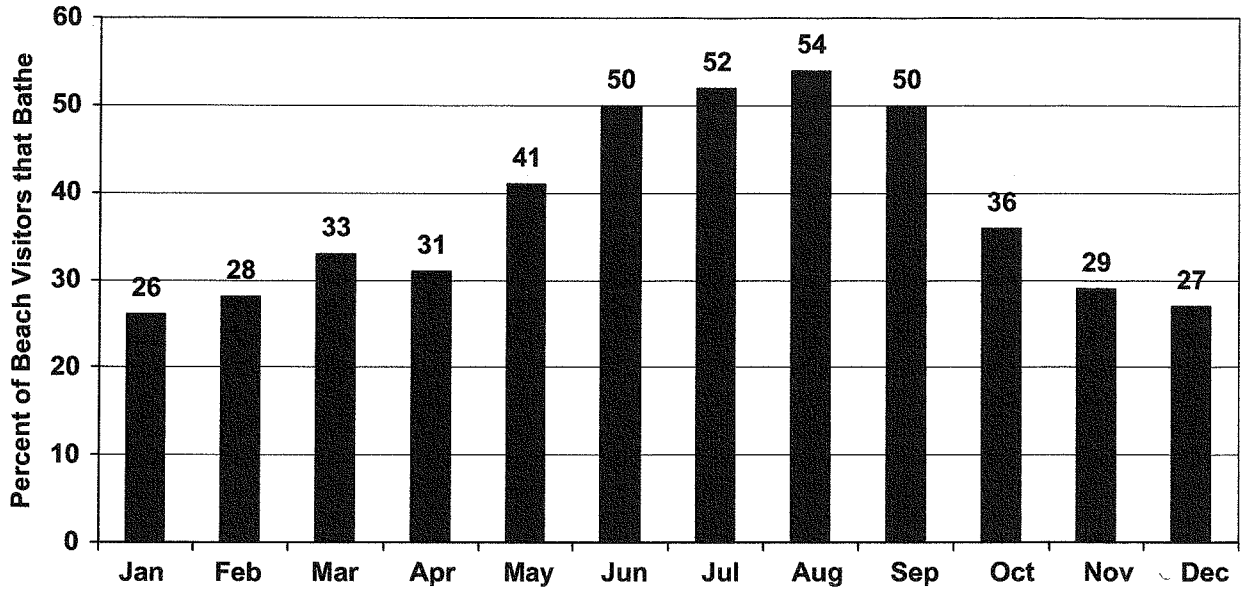

Fig. 4. Fraction of beach visitors that bathe (actual water contract) by month for Southern California beaches (2001–2004).

3.5. Bathing rates by month

BR show dramatic seasonal variability, with rates ranging from a low of 26% during January to a high of 54% in August (Fig. 4). These monthly BR were consistent across the 5 years analyzed.

The rates of both bathing and BA demonstrated very similar seasonal fluctuations. Low rates during the winter months of December, January and February were followed by a transitional period to high rates during the summer months of June, July and August. The concurrent increases in BA and BR amplifies the seasonal fluctuations when calculating the number of BE.

3.6. Bathing events by year

The model computed over 56 million yearly BE in Southern California's recreational marine waters when beach visitors have physical water contact (Table 1, Figs. 2 and 3). This value does not represent 56 million individuals, but rather the total number of exposure events per year. The number of people who bathe each year is lower because a portion of events results from individuals who frequent the beach throughout the year.

3.7. Bathing events by location

Because BE are a direct function of attendance, the distribution of BE across beaches is determined by attendance patterns (Fig. 3). Beaches with the most visitors also have the highest number of bathers (Fig. 5).

Fig. 5. A summer weekend at Huntington beach in Orange County, California.

4. Discussion

Through extensive data collection, mathematical interpolation and modeling, this study quantifies BA and BR for the entire region of Southern California over 5 years. The analysis revealed several distinct and consistent temporal and geographic patterns of beach visitation and BR. These results portray the ebb and flow of the human tide as the beach-going public utilizes the recreational beaches in Southern California. These beaches are very popular destinations for millions of people, and the overall attendance levels are predicted to increase as the population in the region continues to grow rapidly beyond the current 15 million people living in Los Angeles, Orange and San Diego Counties [10].

Although the beaches of Southern California are popular tourist destinations, it is interesting to note the majority of beach visitors are local residents. One study conducted at Santa Monica Beach in Los Angeles County reported 88% of summer beach visitors are California residents, and 78% are with their families [11].

The annual attendance values we present are supported by all three reports previously discussed [1,4,5]. The values we present for monthly BR are greater in value and detail than previously reported due to the more comprehensive data sets derived from direct observations that we used to calculate our values. The consistency of data over several years of daily observations lends further support for the validity of the results presented.

The use of observational data to measure attendance introduces inherent errors due to different people making daily estimations, and other potential influences on the data collection process. However, a study of the accuracy of BA estimates by lifeguard observations at several beaches in Southern California found these estimates to be within 10% of actual values [12]. Another researcher has also reported lifeguard estimation procedures to be accurate [13]. The consistency over years of the generated

annual totals further supports the validity of the data. The total attendance values presented here are slightly conservative due to missing data for smaller beaches and embayments.

5. Conclusions

Currently, there is no established method for measuring BA. Agencies would benefit from a standardized protocol for measuring BA, and a protocol to distribute these data to supervisory agencies and to the State government to facilitate access to this valuable information. Agencies are currently charged with recording daily BA data, so it would be more effective to coordinate their diligent efforts and make it accessible for public analysis.

The results from this study can offer important data for future policy related to beach management, public health, urban planning, environmental sciences and economic development. For example, the data can support effective decision making among businesses in the tourist industry by allowing them to better target their advertising, event locations and promotions. Economists will be able to use these data to better estimate the significant economic contribution of coastal tourism on the economy, and to help prioritize infrastructure investments for the development of this economy. With coastal tourism and recreation accounting for the majority of Southern California's $24 billion annual Ocean Economy [3], it is important to have accurate data on the temporal and geographic distribution of the beach-going public. Environmental scientists concerned with public exposure to coastal water pollution will benefit by having a better understanding of when and where people are going in the water. Regional water quality managers and public health officials will benefit from having more refined and precise data to rely upon to ensure the safe enjoyment of this important recreational resource. Knowledge of when and where people use recreational marine waters combined with historical pollution data for individual beaches can help with proactive decision making in an effort to avoid public health risks. Regional water quality managers may use these results to justify increasing or decreasing resource allocations based on actual need. Beach managers such as lifeguards and local police may be able to use the daily beach-specific data to help protect public safety. Comprehensive beach usage data provide beach managers with information and perspective for resource allocation decisions. This information also helps with understanding the magnitude of demand and impacts the infrastructure may be experiencing. Data may also help managers understand if certain areas are being under or over utilized. These data provide a sound foundation for many potential applications in future analysis.

Acknowledgments

We are very grateful to all the lifeguard agencies, parks departments and environmental health departments, along with their hospitable personnel, for their assistance in compiling all the data. In particular, we would like to acknowledge the assistance of Captain Rich Stropky, Captain Jim Lischer, Captain Ray Duncan, Captain Eric Bauer, Maria Bird, and Jason Young. We also thank Mahmoud El-Gaouhry, Joshua Caplan and the Department of Academic and Research Computing at Portland State University in Oregon.

References

[1] Kildow J, Shivendu S. Valuing California Beaches. In: Presented at: the beach economics workshop. University of Southern California, 2001.
[2] King P. The fiscal impact of beaches in California. In: A report commissioned by California department of boating and waterways. San Francisco State University: Public Research Institute; 1999.
[3] Kildow J, Colgen CS. California's ocean economy. The national ocean economics program. 2005.
[4] United States Lifesaving Association. ⟨www.usla.org/publicinfo/⟩, accessed May 2006.
[5] Leeworthy VR, Wiley PC. Current participation in marine recreation. National oceanic and atmospheric administration. 2001.
[6] MEC Analytical. Water-contact ocean recreation in Orange County. Fountain Valley, California, Orange County sanitation district. 1996.
[7] Hanneman WM, Pendleton L, Mohn C, Hilger J, Kurisawa K, Layton D, et al. Using revealed preference models to estimate the affect of coastal water quality on beach choice in Southern California. National Oceanic and Atmospheric Administration, Mineral Management Service, The California State Water Resources Control Board, California Department of Fish and Game; 2004.
[8] Leeworthy VR. Personal communiqué. November, 2005.
[9] Bartels RH, Beatty JC, Barsky BA. Hermite and cubic spline interpolation. In: An introduction to splines for use in computer graphics and geometric modelling. San Francisco, CA: Morgan Kaufmann; 1998. p. 9–17 [Chapter 3].
[10] US Department of Commerce. Population estimates for Counties in Southern California in 2005. US Census Bureau, Washington, DC. ⟨www.census.gov⟩, accessed May 2006.
[11] Haile RW, et al. An epidemiological study of possible adverse health effects of swimming in Santa Monica Bay. Report for Santa Monica Bay restoration project. 1996.
[12] Hanneman WM. Final conclusions of Professor Michael Hanneman regarding lost recreational damages resulting from the American Trader Oil Spill. Report submitted to the State of California Attorney General's Office. August 17, 1997.
[13] Ryan JA. The human tide: an assessment of procedures for estimating daily peak beach attendance. Master of Arts Thesis, San Diego State University, 2003.