Beach Users' Perceptions and Knowledge of Engineered Retention Structures in California, USA

Nicole Kinsman, Department of Earth & Planetary Sciences, University of California, Santa Cruz, California, USA
Gary B. Griggs, Institute of Marine Sciences, University of California, Santa Cruz, California, USA

Introduction

In densely populated coastal settings, wide sandy beaches are revenue-generating recreational areas and protective buffers between the ocean and backshore development. Engineered sediment retention structures, such as shore-perpendicular groins, are used to stabilize and protect these important resources from erosion by mimicking natural headlands and trapping the alongshore movement of sand (see Everts and Eldon, 2000; Kraus et al., 1994). Hardened sediment barriers may also be designed in conjunction with beach nourishment to extend project lifespans.

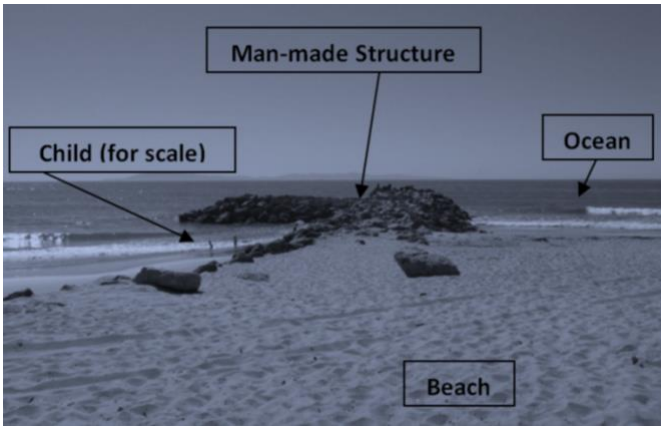

Figure 1: Spurred groin at Greenock Lane, Ventura Beach, California (October 2007).

Artificial littoral barriers, such as seen in figure 1, have a long history of influencing the size and character of many of the sandy beaches along California's coastline (Everts Coastal, 2002; Wiegel, 1994). More than 150 groins and similar sediment barriers are responsible for stabilizing 18% of the state's total exposed sandy beach area (Kinsman and Griggs, 2010). However, not all of these structures have been effective and this net increase in statewide beach extent has not come without occurrences of downcoast erosion (e.g. Capitola Beach, Santa Cruz; Griggs and Johnson, 1976), which can have negative impact on public opinion of this engineering practice.

As California continues to experience a decline in overall sediment inputs to the coast (Willis and Griggs, 2003; Slagel and Griggs, 2007) and declines in opportunistic nourishment, the

increased use of beach nourishment projects may be necessary to maintain existing beach widths (Flick and Ewing, 2009; King, 2008). Due to California's exposure to high wave energy (unfavorable to beach nourishment), the high cost of beach nourishment projects (King, 2008) and the demonstrated record of successful beach stabilization by engineered structures within the state, there is renewed interest in considering artificial littoral barriers as viable components of future management projects (CSMW, 2008). Prior to renewed consideration of these structures within regional sediment plans, coastal planners should be knowledgeable of contemporary public opinion regarding existing groins and rubblemound structures within the state. In order to assist in this effort, we conducted a questionnaire-based study of frequent California beach users' perceptions of sediment retention structures.

Background on perceptions of engineered beach stabilization

In the United States, an abundance of coastal engineering projects undertaken during the early to mid-1900's resulted in numerous occurrences of downcoast erosion due to a poor understanding of regional sediment transport. The failures within this mixed record of project outcomes were widely reported by the media, spurring a legacy of aversion towards the construction of littoral barriers for beach stabilization (Kraus et al. 1994). By the 1980's, hardened beach retention structures had become a highly controversial form of shore protection and states such as North Carolina and Oregon enacted restrictions on construction of new projects (CBNP, 1995). Some states, such as Florida, went on to dismantle existing groin fields (Beachler and Higgins, 1990).

By the 1990's, increased awareness of littoral transport processes, knowledge of project successes outside of the US, and improved beach nourishment practices served to dispel some of the misconceptions surrounding the use of hardened retention structures for coastal protection (Truitt et al., 1993). Some coastal managers recognized the potential for the prudent use of littoral barriers as an erosion control measure, particularly in conjunction with beach nourishment. In 2002 the South Carolina General Assembly amended the 1988 Beachfront Management Act, which prohibited the construction or repairing of groins, to allow for their limited construction within the state. In North Carolina, Senate Bill 823 was passed onto the house on April 30, 2009. This bill allows the state's Coastal Resources Commission to authorize the construction of terminal groin structures for the purposes of coastal stabilization. The national trend by state agencies to reconsider the use of engineered sand retention structures is reflected in California's working drafts of the statewide Sediment Master Plan. Additionally, the 2002 California Beach Restoration Study contained an entire chapter on beach nourishment concepts, including a section on the possible use of existing and new man-made littoral barriers to prolong nourishment lifespans. Despite these recent shifts in policy, the use of engineered structures for beach stabilization remains a topic of debate in the American coastal planning community, and the idea that a continued negative perception of these structures persists within the collective conscious of American coastal residents is commonly cited (e.g. Nordstrom, 2000; Mason et al., 1997). Some examples of blanket statements referencing the condemnation of this management practice by the general public include:

- "Most knowledgeable people view groins as inherently bad news." - Hyndman and Hyndman (2009), Undergraduate Textbook
- "[The use of hardened structures is] one of the most common and yet most hated approaches to reducing beach erosion in America." - Douglass (2002), Ocean Engineering Series

- "Beach goers find [groins] to be unsightly and dangerous." - Pickett (2008), Popular Press Article
- "Arguments against artificial beach-retention structures are underperformance of stated objectives, adverse impacts and unsightliness." - Everts and Eldon (2000), Peer Reviewed Journal

While American coastal residents are often characterized as disliking or being unfamiliar with sediment retention structures, studies from other parts of the world suggest that these structures are liked by many coastal residents and visitors. In 2005, Williams et al. conducted a public opinion survey of engineered beach aesthetics in Wales, UK which revealed a strong preference for groined beaches. Beach users in this European survey cited that the structures improved the coastline by "breaking up" the beach, by providing wind breaks, seating/sunning areas and places for children to play. Respondents in this survey also stated that the rubblemound structures on Welsh beaches are beautiful, familiar and part of their cultural heritage. A similar sentiment of cultural affinity was reported by Walsh et al. (1997) on the Gold Coast of Australia, where residents expressed concern over the proposed removal of a groin considered to be "an important part of the history of the area." In 2004, a study of tourist's perceptions of beaches in Poland found that groins ranked very low on the list of what tourists disliked about the beach (only 1.25%, n= ~300; Jedrzejczak, 2004).

Survey methods

Questionnaire design

Information concerning the public's perceptions of artificial coastal retention structures was derived from a voluntary questionnaire survey. The survey was piloted in 2008 then administered to 323 people through the mail (n=60) and on the internet (n=263) over a two-year period from 2008 to 2010. Participants were solicited though the Surfrider Foundation network, through contact with coastal homeowner's associations, local city councils and by word of mouth. Questionnaire distribution efforts were focused in Southern California near the greatest number of engineered coastal structures in the state. Unlike many coastal perception surveys (e.g. Morgan, 1999; Montgomery, 2000) that target tourists, this survey was targeted towards coastal residents who regularly interact with the coastline.

The questionnaire was designed to evaluate the validity of common blanket statements about the perceptions that American beach users have of retention structures. The survey contains of a mixture of multiple choice and open-ended questions in three parts addressing:

1. The respondent's relationship with the coastline such as town of residence, duration of residence, age, frequency of beach attendance and the nature of their beach use. (6 questions)
2. The respondent's opinion of beach nourishment, coastal engineering structures (rubblemound construction), the safety concerns and the effect of structures on beach morphology, aesthetics and ecology. (6 questions) This section also gages the respondent's familiarity with and overall reaction to common coastal engineering terms. (8 terms)
3. The respondent's knowledge of structure performance. (5 open-ended questions; discussed only briefly in this report)

The questions were designed with input from non-experts and coastal scientists. In order to reduce bias, generalized terms were used whenever possible to describe coastal management

practices; for example, questions pertaining to beach nourishment asked about the "human addition of sand to local beaches." For all questions pertaining to the respondent's opinion of engineered rubblemound structures, participants were shown the photograph in figure 1 and asked to think of a similar structure on a beach in their area. The inclusion of personal identifying information (name, contact information) was optional and included only for the purpose of allowing respondents to participate in similar future studies.

Analysis of responses

At the end of the two year study period (June 2010), 323 survey responses had been received. Demographic information is presented to illustrate any biases in responses based on the underlying sample population. For nominal close-ended questions, we calculated the percentage of total responses for each answer and defined the central tendency with the mode. We also tested the sample set using the non-parametric coefficient Cramér's V to measure correlation between opinion and demographic responses. Only the most significant correlations (conventional maximum of $p=0.05$) have been presented here. Reaction to individual coastal engineering terms formed an ordinal data set (strongly negative to strongly positive) and, due to the normal distribution of responses, we utilized graphical skewness to describe the overall response of the survey participants. Total survey responses from individual questions were lower than the full number of responses ($n<323$) due to people leaving questions blank.

Results

Survey demographics

The geographic distribution of the 323 questionnaire responses illustrated in figure 2 represent the coastal counties where the participants reside or visit most frequently. The vast majority of respondents (71.2%) reside in the five southern-most coastal counties where 75% of the shore-normal structures in California are located (Kinsman and Griggs, 2010).

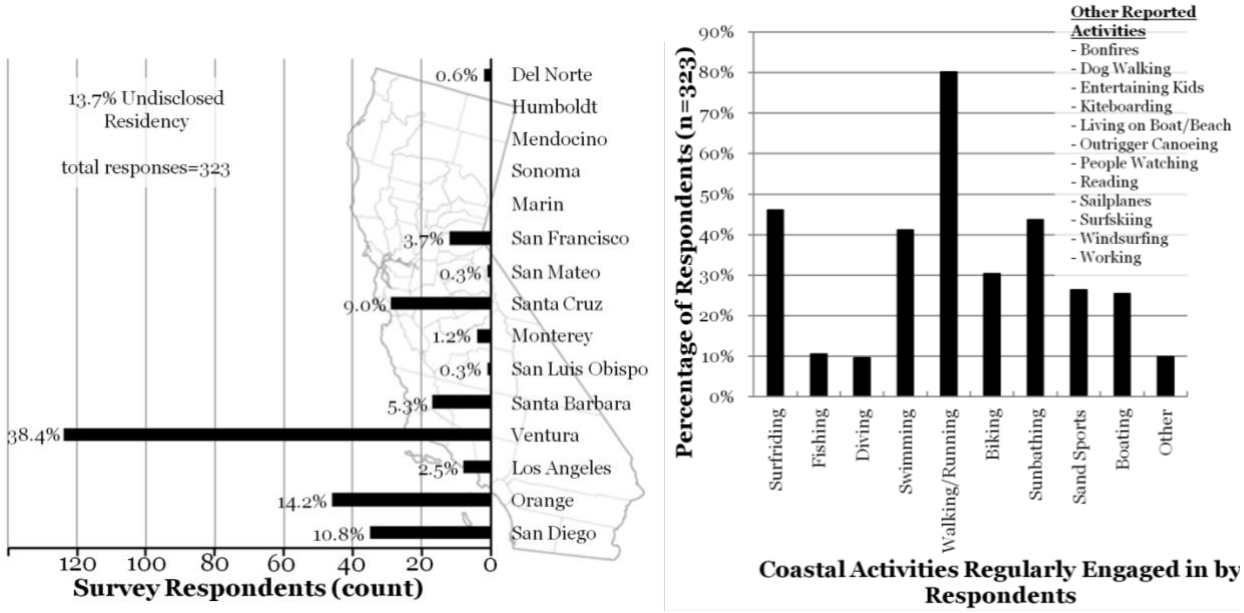

Figure 2: Histograms displaying the geographic distribution of all survey respondents by county (left) and participants' reported beach activities.

Regular beach-goers were common amongst survey participants, with the frequency of beach attendance split roughly in half between people who visited the beach at least once per week and less than once per week; only 16.7% reported an attendance of less than once per month. Most participants reported visiting the beach either year-round (87.0%) or more frequently in the summer (19.2%) A wide range of coastal activities are engaged in by participants of this survey, the full range of reported coastal activities is shown in figure 2; however, no significant correlation was observed between the types of activities people engaged in and their opinions of coastal management terms or engineered structure performance.

As illustrated in figure 3, a vast majority of participants in this study are over the age of 50 and have lived on the coast for 20 years or more. These two factors were shown to statistically correlate with opinions of rubblemound structures, as discussed in the following section. The large sample size of older coastal residents also means that more respondents were likely to have observed the construction of rubblemound structures and are more familiar with earlier baseline conditions for the state's beaches. Of the 323 people participating in this study, 35.9% indicated a willingness to participate in follow-up questions or in a similar study.

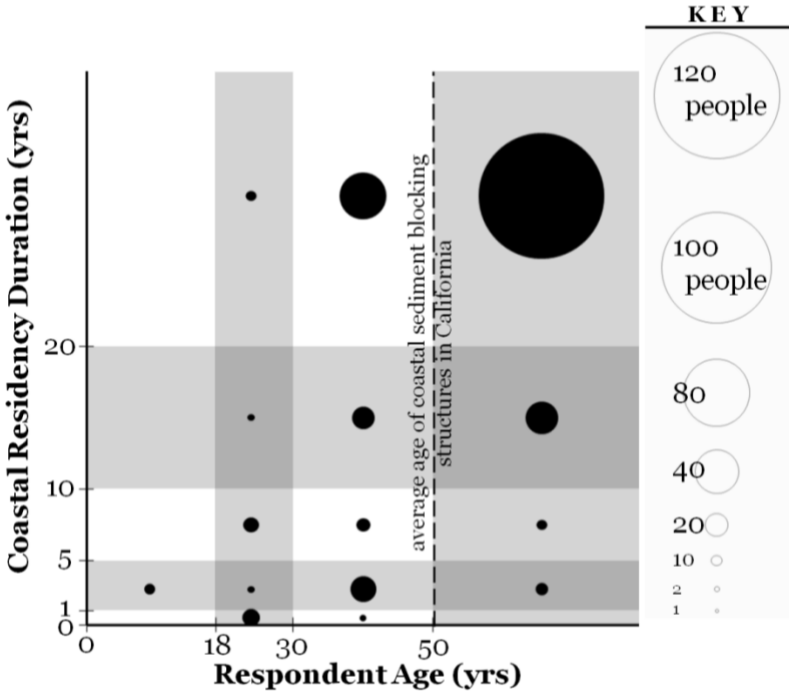

Figure 3: Distribution of survey participants by age and the duration of their residency.

Public opinion of engineered beach stabilization along California's coastline

Some of the multiple choice questions that address commonly cited perceptions of beach retention structures are shown in tables 1-2. Each question is grouped with the demographic characteristic that it was found to most strongly correlate with. Less than 11% of the people surveyed indicated that they could not think of a structure similar to the one shown in figure 1 on a beach that they frequently visited. All of the respondents in this survey that indicated they could not think of a nearby structure were under 50 years of age. A majority of the entire surveyed group considered such structures to be a “part of the beach that they do not really think about much.” Respondents under the age of 50 were statistically more likely to have a favorable

or neutral opinion of these structures, compared to respondents over the age of 50. Older residents were more likely to consider these structures an "unnecessary annoyance" (see table 1).

Table 1: General opinion of structures with regard to age.

Question:	Multiple Choice Answers:	Age <50 (n=143)	Age >50 (n=158)	Total (n=301)
Think structure [similar to figure 1] on a beach that you frequently visit. Which statement is closest to your own opinion?	☺ "I like it, I think it serves a useful purpose and improves the beach."	21.7%	13.3%	17.3%
	😐 "I consider the structure to be a part of the beach and I don't really think about it much."	51.0%	42.4%	46.5%
	☹ "I think of the structure as an unnecessary annoyance."	20.3%	44.3%	32.9%
	Significance of above data:	**$\chi^2 = 17.14$ $df = 2$ $p = 0.000$**		
	? "I don't know or I can't think of a structure near me."	7.0%	0.0%	3.3%

Opinions of the visual impact on beaches and the downcoast effect of these structures correlate most strongly with visit frequency (see table 2). Overwhelmingly, the majority of respondents indicated that they found the aesthetic impact of these structures to be negligible (70.3%), although 16.2% of these people indicated that they would change the appearance if the option was available. People who visited the beach more than once per week were 22.0% more likely to indicate that some of these structures have a negative impact on downcoast beaches, while people who do not visit beaches as frequently were more likely to indicate no downcoast effects (31.4%), or uncertainty about these effects (29.4%). From a safety perspective, 70.4% of all respondents said that they did not consider these structures to be dangerous, with newer residents (<20 years) indicating a lower assessment of the safety of such structures. Newer residents were also more likely to believe that these structures trap additional litter and pollutants, but the majority of respondents (58.7%) did not share this view.

Table 2: Opinion of visual impact and downcoast impacts with regard to visit frequency.

Questions:	Multiple Choice Answers:	Visit Freq. < 1/week (n=155)	Visit Freq. > 1/week (n=148)	Total (n=303)
Which statement is closest to your opinion on the visual impact of these structures?	☹ They are eyesores on our beautiful beaches.	19.1%	17.1%	18.5%
	😐 I don't mind them but I would change their appearance if given the option.	9.6%	23.3%	16.2%
	😐 I think the aesthetic impact is negligible.	63.1%	44.5%	54.1%
	☺ They improve the appearance of the beach.	7.6%	15.1%	11.2%
	Significance:	**$\chi^2 = 17.62$ $df = 3$ $p = 0.001$**		
Which of the following statements do you most closely agree with?	☹ All of these structures have a negative impact on areas located down the coast.	5.9%	8.7%	7.3%
	😐 Some these structures have a negative impact on areas located down the coast.	33.3%	55.3%	44.2%
	☺ None of these structures have a negative impact on areas located down the coast.	31.4%	21.3%	14.7%
	? I don't know.	29.4%	14.7%	22.1%
	Significance:	**$\chi^2 = 19.44$ $df = 3$ $p = 0.000$**		

Respondents' overall reactions to eight common coastal management terms are shown in table 3. There were near-normal distributions amongst the ordinal response options for all of the terms, with no strong correlation between responses and demographics. The only term that induced a slight negative skewness was "Sediment Retention Structure." Both "Coastal Management" and "Jetty" were skewed strongly towards the positive end of the spectrum. The most significant result of this portion of the questionnaire lies in the number of people who were unfamiliar with some of the terms. Approximately 15% of the survey participants were unfamiliar with the terms "Groin" or "Sediment Retention Structure." A full 28.2% indicated that they were unfamiliar with the term "Managed Retreat."

Table 3: Respondents' opinions of terms associated with coastal engineering practices on an ordinal scale from strongly negative to strongly positive. A negative skewness value corresponds to more responses on the positive end of the scale.

Term	Overall Response (central tendency/median)	Skewness Value (*S*)	Unfamiliar
Coastal Management	Very Positive	-0.597	3.0%
Beach Nourishment	Neutral	0.033	2.3%
Sediment Retention Structure	Slightly Negative	0.161	13.9%
Groin	Slightly Positive	-0.193	16.3%
Jetty	Very Positive	-0.542	2.5%
Breakwater	Positive	-0.414	2.6%
Dredging	Slightly Positive	-0.158	2.9%
Managed Retreat	Neutral	0.090	28.2%

Common themes in the open-ended responses in regards to effects on recreation included: wider usable beach area, new sand bars for surfing, uneven nearshore unsafe for children, changes to sand quality (both improved and diminished), disruption at visitor facilities, a decline in nearshore fishing, drifting sand, and more visitors. Some responses mentioned improvements to channel navigation as a result of dredging and most respondents commented that short-term effects were negative but that they saw long-term positive effects, mostly a result of increased overall beach size.

In addition to specific open-ended questions, more than half of the survey participants volunteered extensive comments about man-made structures or coastal management in their area in an additional space at the end of the survey. These comments fell into four main categories: the survey participant's personal philosophy towards coastal management, description of an observed process or a specific site in greater detail, a complaint about local beach management decisions or a desire to share or learn more about these topics.

Discussion

Disparity between opinion responses and prevailing thought

The survey design accomplished the stated goals of reaching a diverse sample of coastal residents and regular beach users. Less than 10% of respondents were unable to think of a rubblemound-type structure on a beach near them. An initial concern was that biased results

would arise from primary survey distribution to two groups with possibly divergent interests, e.g. coastal activists and homeowner associations. This would have resulted in a bimodal distribution of opinions. However, normal unimodal distributions were observed in responses to all ordinal survey questions, suggesting that the use of retention structures is a much less polarized topic in California than it has frequently been portrayed to be.

Responses to parts of the questionnaire that addressed public opinion illustrated a collective feeling of neutrality on the subject of coastal engineering structures, with a positive response to the use of coastal management practices in general. Correlations between demographic characteristics and opinion centered around differences in age, residency duration and visit frequency. For example, non-regular visitors expressed that they felt less knowledgeable about the downcoast effects of engineered structures and younger residents indicted that they think of such structures as "part of the beach" more than older respondents do, most likely because fewer have known the beach in a pre-modified condition. Tunstall and Panning-Roswell (1998) explained that, to a non-tourist, the beach might be a "regular and routine part of their everyday experience," which they might sometimes take for granted though they might have "heightened awareness." Many of the trends in opinion that were exhibited in this portion of the study are consistent with extending this concept to engineered coastal structures.

The relatively neutral to favorable opinion of coastal structures illustrated by the overall response to this study is in stark contrast with the common portrayal of the public perception of engineered beach stabilization as highly negative. Less than 35% of the people in this survey felt structures near them were unnecessary, less than 30% believed such structures to be dangerous and less than 20% disliked their appearance entirely. Certainly, strong opposition to engineered solutions does represent the views of a fraction of the population, but the results of this survey suggest that this is not representative of the majority of the population, and coastal managers must be careful not to accept blanket generalizations about public opinion. While the results of this study suggest that coastal residents may not have a negative view of existing engineered structures on their local beaches, this does not mean that they would necessarily support the new construction or modification of a structure. For example, in 2009 the California Coastal Commission rejected a plan to increase piling density under a pier at Goleta beach near Santa Barbara for the purposes of beach stabilization.

There are several possible explanations for the apparent disconnect between reported opinions and the opinions of the population as a whole. One possible explanation is that opponents of engineered coastal structures are simply more vocal than their counterparts. These voices may have been further amplified by the popular press in their attempt to present superficially balanced arguments. This reporting practice often results in popular discourse separating from scientific discourse (see Boykoff and Boykoff's 2004 discussion of Global Warming coverage) and the propagation of misconceptions. An additional factor that may result in skewed media coverage of public perception is that arguments against the use of hardened structures for beach stabilization more frequently reference examples of projects located in settings that are not analogous to proposed project locations.

Another possibility to explain the discrepancy is that opinions are different in California then elsewhere, or are different at this point in time that they have been in the past. A shifting opinion

of structure performance amongst Californians today may be the result of the perceived long-term advantages of these structures, that many respondents described in open ended questions, have outweighed the negatives on California's low sediment and high energy coastline. Likewise a shift in views may be the result of any negative effects of such structures fading from the collective memories of the coastal population with age. While it would be difficult to determine what opinions Californians held of structures during their initial construction, it would be useful to conduct a similar study to this on the Atlantic or Gulf coast to determine if reports of negative opinions are being derived from sentiments in another part of the country.

The use of open-ended questions allowed non-experts to speak about coastal changes in their own language. Some terms such as “groin” were unfamiliar to nearly 1/5 of the survey participants. The practice of “managed retreat” was also unfamiliar to a surprising number of respondents considering its prevalence in many Environmental Impact Reports. These are examples of how language differences can impede useful discussions of coastal management options and are areas for necessary educational outreach. While residents may not be familiar with engineering terms such as “littoral drift,” “fillet” or “salient beach”, they used a range of terms to describe the same features such as “saw-toothed” and “bulging.” In turn, coastal engineers and planners could improve their ability to communicate with the public by drawing from this vocabulary in order to more effectively communicate with the public.

Conclusions

This questionnaire was able to ascertain public opinion of engineered beach retention strategies in California. Through the use of a questionnaire survey, we have shown that public perceptions of existing rubblemound structures in the state of California are much less polarized than previously thought and that a negative perception does not dominate Californians' views of coastal engineering structures. Our findings urge caution against the oversimplification of public opinion and, while engineered structures are not a good solution for beach stabilization in all coastal settings, planners must be careful not to dismiss engineered alternatives due to broad generalizations about public opinion.

Acknowledgments

Primary financial support for this study was provided by the University of California, Institute of Marine Sciences through a 2008 Friends of Long Marine Lab Student Research and Education Award. Additional support was provided by the Coastal Sediment Management Workgroup of the California Department of Boating and Waterways. The authors would like to acknowledge the Surfrider Foundation members who were instrumental in the initial distribution of this survey. Additional thanks to Matthew Malone for inspiring the local-knowledge component of this project.

References

Beachler, K. and S. Higgins. 1990. Hollywood and Hallandale: building Florida’s beaches in the 1990s. *Shore and Beach* 60(3): 15.

Boykoff M. and J. Boykoff. 2004. Balance as bias: global warming and the US prestige press. *Global Environmental Change* 14 (2): 125-136.

Coastal Sediment Management Workgroup (CSMW). 2008. *Draft California beach restoration survey*. Online: http://www.dbw.ca.gov/

Douglass, S. 2002. Saving America's beaches: The causes of & solutions to beach erosion, in *Advanced Series on Ocean Engineering*, vol. 19, 91 p. Washington DC: World Scientific.

Everts, C. and C. Eldon. 2000. Beach retention structures and wide sandy beaches in Southern California. *Shore and Beach* 68(3):11-22.

Everts Coastal, 2002. *Impact of sand retention structures on Southern and Central California Beaches*, 103 p. California Coastal Commission.

Flick, R. and L. Ewing. 2009. Sand volume needs of Southern California beaches as a function of sea level rise rates. *Shore and Beach* 77:36-45.

Griggs, G. and R. Johnson. 1976. Effects of the Santa Cruz Harbor on coastal processes of Northern Monterey Bay, California. *Environmental Geology* 1(5):299-312.

Hyndman, D. and D. Hyndman. 2009. *Natural Hazards and Disasters*, pg. 376. New York: Brooks/Cole.

Jedrzejczak, M. 2004. The modern tourist's perception of the beach: Is the sandy beach a place of conflict between tourism and biodiversity? In *Managing the Baltic Sea, Coastline Reports 2*, ed. G. Schernewski and N. Loserpp, 109-119.

King, P. 2008. Financing beach restoration in California. *Shore and Beach* 76(2):44-52.

Kinsman, N. and G. Griggs. 2010. California coastal sand retention today: Attributes and influence of effective structures. *Shore and Beach* 78(4)/79(1):64-73.

Kraus, N., H. Hanson, and S. Blomgren. 1994. Modern functional design of groin systems. *Proceedings of the 24th International Conference on Coastal Engineering* 2:1327-1342.

Mason, O., W. Neal, and O. Pilkey. 1997. *Living with the Coast of Alaska*, 348 p. Duke University Press.

Montgomery, M. 2000. *Beach nourishment at Pensacola Beach, Florida: Assessment of public perception*. Ph.D. thesis, 152 p. The University of West Florida.

Morgan, R. 1999. Preferences and priorities of recreational beach users. *Journal of Coastal Research* 15(3):653-667.

Nordstrom, K. F., 2000. *Beaches and dunes of developed coasts*. 338 p. Cambridge University.

Committee on Beach Nourishment and Protection (CBNP), National Research Council. 1995. *Beach Nourishment and Protection*. Tech. report, 352 p. The National Academies Press.

Pickett, A., June 2008. Beach erosion takes it in the groin. *Tampa News*.

Truitt, C., N. Kraus, and D. Hayward. 1993. Beach fill performance at the Lido Beach, Florida groin. *Proceedings of Coastal Zone: Beach Nourishment Engineering and Management Considerations* 31-42.

Slagel, M. and G. Griggs. 2007. Cumulative losses of sand to the major littoral cells of California by impoundment behind coastal dams. *Journal of Coastal Research* 252:50-61.

Tunstall, S. and E. Penning-Roswell. 1998. The English beach: experiences and values. *The Geographical Journal* 164(3):319-332.

Walsh, A., R. Tomlinson, and J. McGrath. 1997. *Coastal management implications of groyne removal.* CoastalCOMS, 7 p. Online: http://gccc.coastalcoms.com/history

Wiegel, R., 1994. Ocean beach nourishment on the USA Pacific Coast. *Shore and Beach* 62(1):11-36.

Williams, A., A. Ergin, A. Micallef, and M. Phillips. 2005. Public perception of groyned beaches. *Zeitschrift fur Geomorphology* 141:111-122.

Willis, C. and G. Griggs. 2003. Reductions in fluvial sediment discharge by coastal dams in California and implications for beach sustainability. *The Journal of Geology* 111(2):167-182.