BEACH AND DUNE RESTORATION

This book analyzes the tradeoffs involved in restoring beaches and dunes on intensively developed coasts, the most effective approaches to use, and the ways to educate and involve stakeholders. It identifies restoration strategies that can be employed to enhance natural processes and make coastal landforms more dynamic while maintaining their value for shore protection. In addition to ecological values, the concept of restoration is expanded to include physical, economic, social and ethical principles, and ideals. Compromise management solutions are suggested to accommodate the needs of many different user groups, including municipal managers and individual property owners, whose role has remained unassessed by existing publications on the same issue. The means of overcoming inertia or antagonism to environmentally friendly actions are also discussed. The book is written for coastal scientists, engineers, planners and managers, and also serves as a useful supplementary reference text for courses dealing with issues in coastal management, ecology and environmental ethics.

Karl F. Nordstrom is a Professor at the Institute of Marine and Coastal Sciences at Rutgers, the State University of New Jersey, where he has been teaching for over 30 years. His distinguished career of research into beaches and dunes in oceans and estuarine environments includes receiving Fulbright Senior Scholar Awards (Germany) in 1999 and 2006, and the Grove Karl Gilbert Award for Excellence in Geomorphological Research in 2001. He has worked in the USA, Canada, Australia, Italy, and Germany, and has published numerous books, including Beaches and Dunes of Developed Coasts, also by Cambridge University Press, in 2000. He has contributed to over 80 articles in journals and over 40 chapters in books and edited symposia. He is also on the editorial board of the Journal of Coastal Research and a member of several professional associations on coastal environments and beach preservation.
BEACH AND DUNE RESTORATION

KARL F. NORDSTROM
Institute of Marine and Coastal Sciences
Rutgers University, New Brunswick, USA
Contents

Preface ix
Acknowledgments xi

1 The need for restoration 1
   The problem 1
   Human modifications 4
   Values, goods, and services of beaches and dunes 6
   The need for restoring beaches and dunes 7
   Definitions and approaches to restoration 10
   The elusiveness of a time-dependent target state 14
   Types of restoration projects 15
   Scope of book 16

2 Beach nourishment and impacts 19
   The potential for restoration 19
   General design considerations 20
   Sediment characteristics 23
   Potential negative impacts of nourishment operations 24
   Alternative practices to minimize environmental losses 36
      and enhance values 36
   Alternative designs for beach fills 43
   Restoring sediment characteristics 44
   Monitoring and adaptive management 47
   Concluding statement 47

3 Dune building practices and impacts 49
   Characteristics of human-altered dunes 49
   Dunes built by aeolian transport from nourished beaches 50
   Building dunes by deposit of fill from external sources 52
   Building dunes by beach scraping 54
   Building dunes using sand fences 56
### Contents

Building dunes using vegetation 59  
Building dunes using multiple strategies 63  
Concluding statement 64  

4 Restoring processes, structure, and functions 66  
   Increasing complexity and dynamism 66  
   The issue of dynamism 66  
   Altering or removing shore protection structures 70  
   Restricting beach raking 75  
   Restricting driving on beaches and dunes 77  
   Removing or altering sand-trapping fences 77  
   Protecting endangered species 78  
   Altering growing conditions 79  
   Replacing vegetation 83  
   Restoring slacks 88  
   Allowing time for naturalization 90  
   Determining appropriate levels of dynamism 91  
   Offsite activities 92  
   Concluding statement 93  

5 Options in spatially restricted environments 94  
   Alternative restoration outcomes 94  
   Natural gradient 96  
   Truncated gradient 99  
   Compressed gradient 99  
   Expanded gradient 101  
   Fragmented and decoupled gradients 103  
   Implications 104  

6 A locally based program for beach and dune restoration 107  
   The need for local action 107  
   Gaining acceptance for natural landforms and habitats 108  
   Identifying reference conditions 110  
   Establishing demonstration sites 111  
   Developing guidelines and protocols 114  
   Developing and implementing public education programs 123  
   Maintaining and evaluating restored environments 125  

7 Stakeholder interests, conflicts, and co-operation 129  
   Obtaining public support 129  
   The need for compromise solutions 131  
   Contrasts in stakeholder perceptions and values 131  
   Stakeholder actions 134  
   The resulting landscape 140
## Contents

8 Research needs 141  
   Introduction 141  
   Nourishing beaches 141  
   Building dunes 147  
   Accommodating or controlling dynamism 148  
   Options in spatially restricted environments 150  
   Addressing stakeholder concerns and needs 150  
   Maintaining and evaluating restored environments 152  
   Concluding statement 153

References 154  
Index 184
This book is about restoring landforms and enhancing their functions and services on intensively developed coasts. It is a follow-up to my book *Beaches and Dunes of Developed Coasts*, which identified the many ways beaches and dunes are transformed by human actions and the differences between natural landforms and the human artifacts that replace them. In writing that book, it became obvious that many transformations of the coastal landscape, even those involving construction of new landforms, were being done with little thought given both to the accompanying environmental losses and the potential opportunities for achieving new environmental gains. Traditional beach and dune building practices emphasize the use of landforms for protection and recreation, but that does not preclude adding new natural resource values compatible with those uses. In many cases, the modification of traditional shore protection projects to achieve nature goals can be accomplished with little change in design or cost. I acknowledge that human-use functions will be the driving forces for managing beaches in developed areas, so a return to a condition of pristine nature is not an option. Restored landforms and habitats will be subject to direct human use or indirect effects resulting from land uses in adjacent areas, and these landforms may require periodic human adjustments to survive. The impossibility of returning to pristine nature should not deter efforts to regain elements of the natural environment and reverse the trend toward environmental loss.

The great competition for space near the land–ocean interface and the increasing demands of different interest groups on the new resources made available by constructing beaches and dunes require evaluation of the new environments in a framework that considers physical, biological, and social goals and objectives, and the tradeoffs and compromises involved. This focus on compromise and the need to accommodate different user groups, including shorefront residents and tourists, is another distinguishing characteristic of this book. My working assumption is that some nature is better than none, even if it is imperfect, providing that no better
option is available given the economic or political climate at the time. I consider this assumption valid if the restored environments are considered interim states that will be improved as natural features become more acceptable to stakeholders and greater resources are devoted to improving them.

This book is not a manual of procedures for building beaches and dunes. Numerous books and technical reports provide practical guidelines for emplacing sediment, installing sand-trapping fences, and planting dunes (e.g. CERC 1984; Ranwell and Boar 1986; Technische Adviescommissie voor de Waterkeringen 1995; Dean 2002; US Army Corps of Engineers 2002), and there are many information sheets produced by government departments and environmental commissions, such as the outstanding series of leaflets produced by the Beach Protection Authority of Queensland. Most guidelines, and the studies on which they are based, focus on how to build landforms and habitats rather than how they can or should evolve as natural systems after they are constructed. The principal difference between this book and previous books on beach and dune management is the emphasis on trying to find ways to modify existing practices to enhance natural processes and make landforms more dynamic while maintaining their function as shore protection structures and managing them as natural features after construction. It is intended to be a companion volume to design manuals rather than a substitute for them.
Acknowledgments

Financial support for the many projects that led to results published in this book was provided by the German–American Fulbright Commission, the National Geographic Society, the Interdisciplinary Global Joint Research Grant of Nihon University for 2001 for the Study on Erosion Control of National Land and the NOAA Office of Sea Grant and Extramural Programs, US Department of Commerce, under grant nos. R/S-95002, R/CZM-2002, R/D-2002-1, and R/D-2003-4. The US Government is authorized to produce and distribute reprints for governmental purpose, notwithstanding any copyright notation that may appear hereon. NJSG-99-410. This is Contribution Number 2007-11 of the Rutgers University Institute of Marine and Coastal Sciences.

I am grateful to the following people for information and ideas about restoring beaches and dunes or for help gathering information in the field: Pierluigi Aminti, Edward Anthony, Bas Arens, Derry Bennett, Peter Best, Alan Brampton, Harry de Butts, Dave Carter, Laura Caruso, Massimo Coli, Skip Davis, Ian Eliot, Lucia Fanini, Amy Freestone, Giorgio Fontolan, Ulrike Gamper, Jeff Gebert, Gregorio Gómez-Pina, Rosana Grafals, D’Arcy Green, Jean Marie Hartman, Patrick Hesp, Woody Hobbs, Jacobus Hofstede, Shintaro Hotta, Nancy Jackson, Jim Johannessen, David Jenkins, Reinhard Lampe, Sonja Leipe, Brooke Maslo, Mark Mauriello, Anton McLachlan, Christopher Miller, Julian Orford, Orrin Pilkey, Enzo Pranzini, Nicole Raineault, Tracy Rice, Sher Saini, Felicita Scapini, Douglas Sherman, Hugh Shipman, William Skaradek, David Smith, Horst Sterr, Thomas Terich, Kim Tripp, John van Boxel, Lisa Vandemark, Frank van der Meulen, Allan Williams, and Kit Wright.