Islands in the Sand

Daniel A. McCarthy • Kenyon C. Lindeman
David B. Snyder • Karen G. Holloway-Adkins

Islands in the Sand

Ecology and Management of Nearshore Hardbottom Reefs of East Florida

Springer

Daniel A. McCarthy
Department of Biology and Marine Science
Marine Science Research Institute,
Jacksonville University
Jacksonville, FL, USA

David B. Snyder
CSA Ocean Sciences Inc.
Stuart, FL, USA

Kenyon C. Lindeman
Department of Ocean Engineering and
Marine Sciences, Program in Sustainability,
Florida Institute of Technology
Melbourne, FL, USA

Karen G. Holloway-Adkins
East Coast Biologists, Inc.
Indialantic, FL, USA

ISBN 978-3-030-40356-0 ISBN 978-3-030-40357-7 (eBook)
https://doi.org/10.1007/978-3-030-40357-7

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Foreword

Almost everyone loves the shore. This margin between our own familiar ground and the vast ocean wilderness can both comfort and excite us. Many of us recall serenely filling our senses with surf tumbling onto a beach, only to have that peace punctuated by delight—a sudden and beautiful visage from the sea, a shadow in a wave, a leap and a splash, or a lingering presence offering detailed wonder. That nature and we share more than coincidence of space in this coastal ecosystem. We share a need for it.

This book is about a vital but underappreciated natural feature—Florida's nearshore reefs—oases of life that the authors refer to as "Islands in the Sand." "Underappreciated?" you question. Yes, vastly so. Still, we enjoy these reefs immensely. We prosper from their flora and fauna, and are treated to the landscapes they present at low tide, and through our dive mask. Our profits from nearshore reef services occupy many levels, including the all-important economic benefit measured by dollars. Yet, although we gain from these lovely, diverse, accessible patches of hard sea-bottom, we fail to appreciate the full depth of these shallow reefs. That is to say, we fall short of understanding them, of grasping the habitat's worth and significance, and of knowing outright how our actions can threaten it.

The authors of this book, who are experts across multiple fields, have prepared a detailed ecological description of Florida's coastal reefs. It is a portrayal that is both academic and easily absorbed, and is essential for coastal managers, scientists, or anyone wanting to deepen their coastal relationship. This book catalogs features of nearshore reefs—their dynamic cycles of ecological change, their function as hotspots for biodiversity, their role in the lives of rare species, and in our own lives.

Especially now, our aptitude for the mutual relationship we have with nearshore reefs is crucial to their pulse of persistence. Over eons, these reefs of the surf zone blossomed and withered to the beat of storms and natural sand movement, periodically harboring unique lives lived in haste, and marine animals in formative stages or just passing through. But as our coast has become more crowded, this habitat has suffered from our insistence on permanence within such a dynamic system. Where beach sands once came and went, we construct buildings on dangerous ground requiring defense against change. This messy and expensive coastal battle often

involves pumping sand to artificially replace what the sea consumes, and as an unintended consequence of this engineering, reefs, which contributed to the original value of the real estate, are kept smothered.

The paradox of habitat affinity and habitat harm is precisely why this book is essential. The affinity is self-evident. To visit a Florida beach adorned by nearshore reef at low tide is to experience uniquely accessible nature—life-filled tide pools that tempt the curiosity of children and bring out blissful biophilia in us all. But understanding the potential harm to our nearshore reefs requires insight into how this habitat functions. To the extent that this knowledge leads to watchful stewardship and temperance of our coastal actions, we will keep our mutually beneficial relationship with coastal reefs. On this journey, this book will be our guide.

Blair Witherington, Ph.D., Floridana Beach, Florida, USA
Florida's Living Beaches and *Our Sea Turtles*

Preface

The management of coastal resources is increasingly focused on ecosystem approaches that not only consider primary habitats of concern but their connectivity to adjacent systems. Amidst the cross-shelf mosaic of habitats of mainland Florida's east coast, estuaries with mangroves and seagrasses share many flows, including energy and propagules, with reefs and pelagic waters offshore. Along the highly dynamic land-ocean margin, nearshore hardbottom habitats at 0-4 m depths exist as reef patches for over a thousand documented organisms, amidst long stretches of sand. This volume is the first to describe the fundamentals of the biological, physical, ecological, and management attributes of east Florida's nearshore reefs. Since many coastal residents interact with these reefs and have many questions, we have also tried to make this book accessible to laypersons (e.g., the imagery, a Glossary for technical terms, and book structure) to make these habitats more understandable.

We introduce nearshore hardbottom habitats from southern St. Johns County to northern Miami-Dade County and foundational ecological concepts in Chap. 1. In Chap. 2, we discuss the geology and distribution of nearshore hardbottom reefs and the associated oceanographic setting in the region in which they occur. In Chap. 3 through 6, we synthesize the peer-reviewed scientific and gray literatures, and provide unpublished data based on decades of experience with these reefs among the co-authors. We describe the known species groups, their latitudinal and depth distributions, reproduction, trophic functions, and connectivity for algae and cyanobacteria (Chap. 3), invertebrates (Chap. 4), fishes (Chap. 5), and sea turtles (Chap. 6).

In Chap. 7, we integrate assemblage-scale ecological perspectives among these flora and fauna. We discuss the potential roles of disturbance and latitude in affecting abundance and distribution with respect to habitat use, and populations and energetic connectivity along the east Florida coast. In Chap. 8, the responses of these organisms to varying degrees of natural and anthropogenic disturbances are examined. We then discuss approaches for minimizing impacts to nearshore hardbottom reefs during large fill projects, with a focus on artificial reef mitigation. In Chap. 9, we summarize research findings for each major taxonomic group, nearshore hardbottom reef ecology, and management with a focus on future research opportunities across all issues.

In examining these diverse nearshore hardbottom reef issues, we hope to provide a useful reference for coastal researchers, managers, and educators, as well as anyone else interested in these habitats and their connectivity to the sea and land. We hope this book inspires increased research on these systems and improved science-based conservation of the marine biodiversity of coastal Florida and other regions with nearshore hardbottom reefs.

Jacksonville, FL, USA — Daniel A. McCarthy
Melbourne, FL, USA — Kenyon C. Lindeman
Stuart, FL, USA — David B. Snyder
Indialantic, FL, USA — Karen G. Holloway-Adkins

Acknowledgements

A number of outside reviewers improved this book immensely. We are extremely grateful to these reviewers of one or more chapters: Walter Nelson (US Environmental Protection Agency), Hal Wanless (University of Miami), Mark Fonseca (CSA Ocean Sciences Inc.), Aaron Adams (Bonefish and Tarpon Trust), Vladimir Kosmynin (Florida Department of Environmental Protection (FDEP), Blair Witherington (Archie Carr Center for Sea Turtle Research), Erin Hodel (CSA Ocean Sciences Inc.), Sandra Brooke (Florida State University), Clinton Dawes (University of South Florida), Grant Gilmore (Estuarine, Coastal and Ocean Science, Inc.), Jocelyn Karazsia (NOAA Fisheries), Laura Herren (Harbor Branch Oceanographic Institute), Brian Balcom (CSA Ocean Science Inc.), and Kristen Hart (US Geological Service). This project's original Technical Advisory Committee provided editorial and technical comments for two products: CSA International Inc. (2009) and CSA Ocean Sciences Inc. (2014). TAC members on both included Marty Seeling (FDEP), Vladimir Kosmynin, Roxane Dow (FDEP), Cheryl Miller (Coastal Eco-Group), Jocelyn Karazsia (NOAA Fisheries), Jeff Beal and Robin Trindell (Florida Fish and Wildlife Conservation Commission), Don Deis (PBSJ), Terri Jordan (US Army Corps of Engineers), Danielle Irwin and Lanie Edwards (FDEP), and Kim Colstad (Coastal Technology Corporation).

We received valuable communications and permission to reference unpublished data from many researchers: Gerry Pinto (Jacksonville University) developed an early draft of the arthropod section, Lee Ann Clements for help with ophiuroids and Harry Lee for help with mollusks. Jon Norenburg, Mary Rice, and Michael Boyle of the Smithsonian Marine Station provided significant input on nemertines and sipunculans. Terry Gibson (North Swell Media) provided policy literature. Larry Wood (National Save the Sea Turtle Foundation) and Dean Bagley (Inwater Research Group Inc., University of Central Florida) shared discussions on their sea turtle research. We thank Mike Daniel, Sara Brehm, and many others for their valuable photographs. Staff from agencies and consulting companies provided nearshore hardbottom acreage estimates or other assistance including Ken Banks (Broward County Environmental Protection and Growth Management Department), Brian Flynn (Miami-Dade Department of Environmental Resources Management),

Brian Walker and Lance Jordan (Nova Southeastern University Oceanographic Center), and Janet Phipps and Carmen Vare (Palm Beach County Environmental Resources Management). We thank Stacey Prekel, Quin Robertson, and Jessica Craft of Coastal Protection Engineering for providing monitoring project and acreage data. Brent Gore, Charles Hagans, Kevin Noack, Keith VanGraafeiland, and Chris Dean of CSA Ocean Sciences assisted with aerial imagery, map figures, and hardbottom acreage estimates.

We thank Beth Schoppaul and Heather McCarthy for editorial assistance. For assistance in the field we thank these CSA Ocean Sciences staff: Jeff Pennell, Bo Douglas, Chip Baumberger, Jeff Landgraf, David McGregor, Carl Loomis, Dustin Myers, Frank Johnson, Jeff Schroeder, and Stephen Viada. Ernesto Calix helped with sorting and identifying post-larval fishes. We thank Daryl Adkins, Shannon Hackett, Mario Mota, Jennifer Solis, Shanon Gann, and Dana Karelus from East Coast Biologists Inc. for their assistance with sea turtle surveys. A number of Jacksonville University and Florida Tech students assisted the development of this book. We thank Hannah Knighton, Julia Lyons, Taylor Greene, Montana Steel, Paige Carper, Jessica Fair, Madeline Phelan, Natalie Swaim, Evan Lindeman, and Bryan Harshey for literature work or editing. We thank Alex Paradise, Tayler Massey, Keenan Carpenter, Krystal Dannenhoffer, Brett Durda, and Justina Dacey for student management and for processing algae and invertebrates. We thank the following Jacksonville University students for processing data: Sara Brehm, Devin Resko, Sara Dowudom, Nicole Martin, Rad Murphy, Amber Bruce, Bailey Estrada, Jenna Manis, Erika Kinchen, Logan Wood, Sara Debellis, Megan Zellner, Kyle Bosanko, Ashley Knight, Hannah Roddy, Anthony Flock, and Marina Gonzalez. Bryan, Adam, and Eric Lindeman provided varied assistance. This effort is dedicated to Ed Ricketts and Mike Blatus. Finally, we sincerely thank our families for their support and understanding during the development of this book.

Contents

Author Biography

Daniel A. McCarthy, PhD is a professor in the Department of Biology and Marine Science and the Marine Science Research Institute, Jacksonville University. He is a marine benthic ecologist with over 25 years of field and laboratory research experience. His research has focused on the ecology and restoration of estuarine and coastal reef systems. He obtained his Bachelor of Science at Jacksonville University, Master of Science at Florida State University, and Ph.D. at King's College, University of London. He served as a postdoctoral fellow with the Smithsonian Institution for 3 years before coming to Jacksonville University.

Kenyon C. Lindeman, PhD is a professor in the Department of Ocean Engineering and Marine Sciences, Florida Institute of Technology. His work focuses on nearshore habitats, fishery management, marine protected areas, and coastal climate adaptation. He has worked as a research scientist with NOAA, the University of Miami, and several conservation science nonprofit organizations. Over 70 research publications include articles in over 20 peer-reviewed journals and 4 coauthored or coedited books. He received a Bachelor of Science at FIT, Master of Science at the University of Puerto Rico, and PhD at the Rosenstiel School of Marine and Atmospheric Science, University of Miami.

David B. Snyder, MS is a senior scientist at CSA Ocean Sciences Inc., Stuart, Florida. He is a fish ecologist and marine biologist with more than 35 years of experience. He has participated in marine environmental assessments worldwide and has sampled fishes from a variety of habitats ranging from the continental slope to freshwater streams. Such efforts have included multiple surveys of fishes and epibiota associated with nearshore reefs subject to impact from dredge and fill projects off the eastern and western Florida coasts. He obtained his Bachelor of Science from the University of Florida and his Master of Science from Florida Atlantic University.

Karen G. Holloway-Adkins, PhD is a senior scientist and executive director of East Coast Biologists, Inc. (a non-profit for scientific research and education) in Indialantic, Florida. She has over 28 years of experience in the field of marine biology and sea turtle ecology with research that is focused on inwater developmental habitat and the ecological role of sea turtles in marine ecosystems. She worked 18+ years as a biologist monitoring protected species and habitat at NASA's John F. Kennedy Space Center. She received her Bachelor and Master of Science degrees in Biology from the University of Central Florida and her Doctoral degree from Florida Atlantic University. She currently serves as courtesy affiliate faculty within the Biology Department at both universities.