of global mean sea level rise (estimated to range between 1–2 mm/yr, during the last 100 years), over 70% of the world's sandy coasts and 90% of U.S. beaches are eroding.

Lynn Edgerton, a lawyer for the Natural Resources Defense Council (NRDC), an environmental organization, briefly covers the scientific background of the predicted greenhouse-gas induced climate warming, its implications for future sea level change and its anticipated effects on coastal environments. The main thrust of the book, however, is a review of U.S. federal and state policies with respect to the coastal environment. The difficulty of formulating a consistent coastal policy is magnified by the division of management responsibilities among five federal agencies (the Environmental Protection Agency, the Department of Commerce, the U.S. Army Corps of Engineers, the Department of the Interior, and the Federal Emergency Management Agency, FEMA). The further dispersion of jurisdiction among federal, state and local agencies only underscores the conflict of roles and lack of coordination. Edgerton provides a good summary of relevant state and local regulations, including several site studies for San Francisco Bay, Delaware Bay, Hawaii and Massachusetts. Recommendations are offered to mitigate adverse impacts. Various policy options are examined, including reductions in CO_2 emissions, to incorporation of future sea level changes into land use planning and flood insurance programs. A need exists to factor sea level rise into the shoreline erosion rates and flood frequency statistics of FEMA, but also to allow flexibility in adjusting to new and more accurate sea level rise scenarios, as better data become available.

However, several important considerations are downplayed. The wide range of geographic responses of the shoreline to sea level rise, due to the great variety of physical, oceanographic and meteorological characteristics is not mentioned. No clear distinction is made between episodic storm events, and permanent inundation. The book, furthermore, devotes little space to the engineering responses (*e.g.* hard or soft stabilization, beach nourishment), and the extent to which these measures may have often been counterproductive in the past, by exacerbating erosion problems downdrift (an odd omission from an environmental perspective).

International activities are briefly mentioned (*e.g.* the United Nations Environmental Program, IPCC Coastal Zone Management subgroup). Case studies are presented for the Nile delta, Bangladesh, and the Netherlands. However the particular concerns of island states are not addressed, for example as presented at the Small States Conference on Sea Level Rise, organized by the Republic of Maldives, in 1989.

The book's main strengths are the overview it provides on the maze of federal, state and local regulations, and the set of recommendations for impact mitigation. Although the science background is discussed in greater depth elsewhere, the book is clearly and simply written for coastal managers, policymakers, and anyone else with an interest in the future of our shorelines.

Vivien Gornitz
Columbia University
New York, New York

Paleoshorelines and Prehistory: An Investigation of Method, L. L. Johnson (ed.), assisted by M. Stright, 1992. Boca Raton: CRC Press, 243p. ISBN 0-8493-8855-4.

Prehistoric settlement and land use patterns were closely linked to natural resource availability. In coastal regions, this involved convenient access to shellfish and other marine or intertidal food sources. Inasmuch as the littoral coastal environment responds dynamically to variations in sea level and sediment supply, coastal archeology requires a clear understanding of the evolution of the shoreline over time.

In *Paleoshorelines and Prehistory: An Investigation of Method*, archeological and geological methods are employed to investigate the relation between ancient occupation sites and paleoshoreline positions, and their modification over time by sea level changes. Techniques discussed range from granulometric analysis, to radiocarbon dating of shells from beach ridges and shell middens, to underwater geomorphological mapping, using sidescan sonar and scuba diving, and finally, satellite imagery. Localities described in the book are selected from diverse tectonic settings on islands and the mainland. Examples from tectonically stable areas include the Bahamas and Barbuda Island in the Caribbean; Kotzebue; Alaska; Brazil; and the eastern Gulf of Mexico. Unstable regions encompass areas of tectonic uplift (south-

ern Alaska, Peru) and isostatic rebound (Labrador). Although all of the study sites are in the Western Hemisphere, the methodologies outlined in this book are applicable to coastlines around the world.

The depth of presentation varies greatly, however, from one chapter to another, ranging from preliminary exploratory surveys to extensive multi-disciplinary analysis. A good example of the latter includes the detailed radiocarbon dating of beach ridges in northwest Alaska, coupled with grain size analysis and vegetation mapping, in order to correlate between sites (Mason, Chapter 3). Suguio *et al.* (Chapter 4) examine the geographic distribution of large shell middens (sambaquis) to establish paleoshorelines in Brazil. The base of the sambaqui indicates levels above local high-water spring tide (HWST). Therefore sites far inland periods of higher than present water levels. Supporting evidence for associated changes in estuarine or lagoonal paleosalinity is provided by $^{13/12}C$ isotope ratios. However, the discussion would be strengthened by plotting the spatial distribution of dated samples with respect to the local geology.

In the Shumagin Islands, southern Alaska, Winslow (Chapter 7) and Johnson and Winslow (Chapter 8) tie the occurrence of sites to tectonic reconstructions of paleoshorelines. Past sea levels also figure prominently in the search by Dunbar *et al.* (Chapter 6) for submerged Clovis sites, off the coast of Western Florida. (The Clovis period, ~10,500–13,500 radiocarbon years, BP, was never clearly defined in the text, but could be inferred by inspection of Figure 2, in Chapter 6.) The search area is further narrowed by the likely concentration of sites near karst depressions and chert-rich limestones. However, the depth to the prehistoric shoreline strongly depends on the specific sea level history chosen. While the authors derive depths of between −40 to −50 m from the Curray (1965) sea level curve, a more recent sea level curve (Fairbanks, R., 1989, *Nature*, 342:637–642) suggests depths of −60 m to −100 m during this period, which would significantly shift the locus of future underwater exploration.

Applications of remote sensing extend from submarine scanning to satellite imagery. Garrison (Chapter 5) describes sidescan sonar and high-resolution subbottom prolifer data from the eastern Gulf of Mexico, for underwater reconnaissance mapping of submerged paleoshorelines and karstic formations. Although the 175 m deep sinkhole probably predates the Pleistocene ice ages, the two relict shorelines detected at −36 m and −73 m, respectively, could provide helpful exploration guidelines. In particular, if the Fairbanks sea level curve is correct, the −73 m feature could correspond to the Clovis paleoshoreline.

Moseley *et al.* (Chapter 10) examine coastal processes on space shuttle imagery and aerial photography along the north-central Peruvian coast. Recent beach ridge development is related to mass wasting and erosional episodes triggered off by seismic and meteorological (ENSO or El Niño) events. The implications for pre-Columbian archeology are discussed. An interesting conclusion is that potentially serious eolian erosion could result from future seismic and ENSO events, which would threaten the agricultural reclamation and irrigation projects now underway. Maps and photographs, however, could be labelled more clearly to indicate the localities mentioned. Also, a color key should be provided for the false-color image (Plate 1). The clear blue ascribed to coastal eolian sand extends further inland to other non-sand geomorphologic units.

Interdisciplinary studies often generate contrary interpretations. In Chapter 2, Watters and Donahue debate the geological *vs.* cultural origin of the "Strombus line", on Barbuda Island, in the West Indies. This line is a lithified beach ridge which separates a late Pleistocene limestone formation to the east from a series of northeast to southwest-trending Holocene beach ridges, to the west. At issue is the process by which the shells were deposited on the ridge—whether by wave action or by prehistoric harvesting, and also the interpretation of the radiocarbon dates. To this reader, at least, the case for the natural accumulation of the shells seems more convincing. The strombus ridge most likely predates the nearly perpendicular set of beach ridges, which constitute Palmetto Point Peninsula. The wide range in ^{14}C ages is probably caused by the reworking of these large, strong shells. The youngest dates in the assemblage gives a minimum age for the ridge, *i.e.* ~1,700 radiocarbon years BP. A more fundamental question remains unanswered, however—what changes in storm patterns or wind directions have occurred around 1,700 years ago to cause a nearly 90° shift in beach-ridge orientation?

In summary, this book presents a diverse overview of recent studies in coastal and underwater archeology in the Western Hemisphere, of rele-

vance to archeologists, Quaternary geologists and geomorphologists. The treatment varies from reconnaissance survey to in-depth field and laboratory investigations. Better labelling of maps and figures, in places, would improve the book.

Vivien Gornitz
Columbia University
New York, New York

The Common Tern. Its Breeding Biology and Social Behavior, J. Burger and M. Gochfeld, 1991. New York: Columbia University Press, xvii + 413p. $65.00.

The Common Tern (*Sterna hirundo*) is unusual in that the populations of the northeastern United States have been treated monographically twice, 40 years apart. Thus, this modern text can be compared with the earlier treatment of R. S. Palmer (1941, A behavior study of the Common Tern., *Proc. Boston Soc. Natur. Hist.*, Vol. 42). This comparison permits an unusual perspective on intellectual progress in the field of natural history.

Palmer addressed the environmental "requirements" of Common Tern colony sites, and then presented a detailed descriptive account of tern behavior "during the breeding cycle." In the first section he addressed colony site requirements in terms of isolation from disturbance and predators, availability of food, and the condition of the substrate and vegetation. He also addressed influences of temperature and weather on colony siting, colonial associates (other birds nesting in and around tern colonies), kleptoparasites, and predators. The behavior section is arranged chronologically, from arrival at and occupancy of the colony site through courtship and bonding, nest establishment, incubation, hatching, and behavior of the young. Several more specific aspects of adult behavior (up flights, social attack, fishing, bathing, flocking and preening) are then treated outside the chronological framework.

Burger and Gochfeld also describe the breeding biology of Common Terns, but from the perspective of theoretical questions about the advantages and disadvantages of coloniality, and the costs and benefits of habitat shifts. They present a variety of graphical and numerical models to explain aspects of tern behavior. An introductory chapter briefly describes terns as a group and as colonial species, reviews some of the theoretical literature on coloniality in birds, and gives a brief treatment of food and feeding behavior, with extensive reference to work done by a former student, Carl Safina. Chapter two describes study sites and methods.

The authors' results are presented in seven chapters. In chapter three they briefly review the breeding biology of Common Terns, touching on arrival, courtship, mating, egglaying, incubation, the "chick stage," fledging, and post-fledging. A section on phenology follows, treating superficially the variation among colonies and years, and between salt-marsh and beach colonies. Next is a section on clutch size, followed by a very brief one on activity patterns, and then a more substantial one on synchrony, including the (Fraser) Darling effect. Habitat selection and territoriality are discussed in chapter four. Burger and Gochfeld examine habitat selection at two scales—colony site selection in the regional landscape, and nest site selection within the colony. Banding studies determined that Common Terns readily moved between beach and marsh colony sites. In general, if they returned to a beach colony where they had previously nested, they usually nested very near the same location in the colony, and if they moved, they were as likely to move to a different colony as to a distant part of the original colony. Nest site selection studies indicated that in marsh colonies terns tended to select wrack mats for nest sites, but also used other habitats. They often shared mats with Black Skimmers, and using experiments with artificial mats, the authors found that the tern nests were distributed differently on the mats in the presence versus absence of skimmers.

Aggressive behavior is treated in Chapter five. The authors document differences in frequency of aggressive interactions associated with crowding, with position within the colony (center *vs.* edge), with habitat structure, and with stage of the nesting cycle. The most interesting part of this chapter is the discussion of aggression from the perspective of frequency of intrusion. Chapter six covers predation, vigilance, and antipredator behavior. Burger and Gochfeld noted seven mammalian predators, and eleven avian predators. They also discussed depredation by ants, and noted mobbing of diamondback terrapins. They described the types and intensity of response to predators appearing at the colonies they observed,