

COVER PHOTOGRAPH AND FRONT MATTER: ACADIA NATIONAL PARK, MAINE, U.S.A.

Source: Journal of Coastal Research, 29(6a)

Published By: Coastal Education and Research Foundation

URL: https://doi.org/10.2112/1551-5036-29.6a.fmii

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.



COVER PHOTOGRAPH





ACADIA NATIONAL PARK, MAINE, U.S.A.

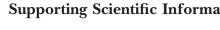
This popular sandy beach is seen in the fall season with the foliage in color. Yellow leaves come from birch trees (*Betula* sp.), red leaves from maples (*Acer* sp.) and the green are spruce (*Picea* sp.) and fir (*Abies* sp.) trees. This is a youthful forest that burned in 1947. The beach is composed of cold-water carbonate sands comprised of barnacles (*Balanus* sp.), blue mussels (*Mytilus edulis*) and echinoderm (*Strongylocentrotus droebachiensis*) spines. The mountain in the background is composed of Silurian granite. (Photograph taken October 2008, and caption by Joseph T. Kelley, Department of Earth Sciences, University of Maine, U.S.A.)



JOURNAL OF COASTAL RESEARCH

An International Forum for the Littoral Sciences

Supporting Scientific Information



- AZTI Tecnalia [Pasaia, Spain; www.azti.es/]
- Coastal and Hydraulics Laboratory (CHL), US Army Corps of EngineersH [Vicksburg, Mississippi, U.S.A.; http://chl.erdc.usace.army.mil/]
- Coastal and Marine Geology Program (CMGP), U.S. Geologic Survey (USGS) [Reston, Virginia, U.S.A.; http://marine.usgs.gov/]
- Coastal Research Laboratory (CRL), University of South Florida [Tampa, Florida, U.S.A.; http://crl.usf.edu/]
- Commission on Coastal System (CCS), International Geographical Union (IGU) [http://www.igu-ccs.org/]
- Consorzio Nazionale Interuniversitario per le Scienze del Mare (Co.N.I.S.Ma.) [Rome, Italy; www.conisma.it/]
- Deltares Institute [Delft, The Netherlands; http://www.deltares.nl/en/coast-sea]
- Department of Geosciences, Florida Atlantic University (FAU) [Boca Raton, Florida, U.S.A.; http://www.geosciences.fau.edu/l
- e-Geo Center for Geographical and Regional Planning Studies [Lisbon, Portugal; http://e-geo.fcsh.unl.pt/]
- Institute of Marine and Coastal Sciences (IMCS), Rutgers University [New Brunswick, New Jersey, U.S.A.; http://marine.rutgers.edu/main/]
- Louisiana Coastal Protection & Restoration Authority (CPRA) [Baton Rouge, Louisiana, U.S.A.; www.coastal. louisiana.gov/]
- Royal Belgian Institute of Natural Sciences: Management Unit of the North Sea Mathematical Models (MUMM). [Brussels, Belgium; www.mumm.ac.be/]

Aims and Scope of the Journal

Journal of Coastal Research, an International Forum for the Littoral Sciences, is dedicated to all aspects of coastal research. These include geology, biology, geomorphology (physical geography), climate, littoral oceanography, hydrography, coastal hydraulics, environmental (resource) management, engineering, and remote sensing. Although each field functions effectively within itsownpurview, the cross-disciplinary nature of coastal studies requires familiarity with other fields as well. Hence, the scope of topics is necessarily broad in order to address the complexity of coastal biophysical and socio-economic interactions. Because of the wide range of interrelated topics, the journal invites original contributions and manuscripts dealing with theory, methodology, techniques, and field or applied topic studies on interdisciplinary coastal issues.

The journal encourages the dissemination of knowledge and understanding of the coastal zone by promoting cooperation and communication between specialists in different disciplines. Natural scientists, for example, are encouraged to collaborate with professionals in other fields to prepare contributions relating to the coastal zone that foster increased appreciation of coastal environments and processes. By means of this journal, with its scholarly and professional papers, systematic review articles, book and symposia reviews, communications and news, and special topical issues, an international forum for the development of integrated coastal research is provided.

Advertising, Editorial, and Subscription Information

Advertising and Editorial Office: All advertising and editorial correspondence should be sent to Dr. Charles W. Finkl, Editor-in-Chief, Journal of Coastal Research, 5130 NW 54th Street, Coconut Creek, FL 33073, U.S.A. PHONE: 828-333-2300. E-MAIL: cfinkl@cerf-jcr.com.

Subscription Information: The Journal of Coastal Research is a bimonthly publication. Calendar-year (2013) print and online subscription prices for the JCR are: \$115.00 for US CERF members / \$125.00 for International CERF members (\$95.00 for online only), and \$519.00 for US institutions / \$541.00 for International institutions (\$437.00 for online only). Additional surface charges may apply to subscribers located outside of the USA. For additional membership and subscription forms and information, please go to www.CERF-JCR.org. To obtain a membership or subscription form by mail, please send request to Journal of Coastal Research, P.O. Box 7065, Lawrence, KS 66044. Back Issues and Special Issues of the JCR, when available, can be directly purchased at www.CERF-JCR.org.

The Journal of Coastal Research is currently surveyed in Applied Science & Technology Abstracts; Applied Science & Technology Index (H.W. Wilson); Aquatic Sciences & Fisheries Abstracts; BIOBASE; Biological Abstracts; BIOSIS Previews (Thomson); CAB International Abstracts (CABI); CSA Civil Engineering Abstracts (ProQuest); Current Awareness in Biological Sciences (Elsevier); Current Contents/Agriculture, Biology, & Environmental Sciences (Thomson); Ecology Abstracts (ProQuest); Environmental Sciences & Pollution Management; GeoAbstracts [Geographical Abstracts: Physical Geography; Ecological Abstracts; Geological Abstracts; GEOBASE] (Elsevier); GeoRef; Meteorological & Geoastrophysical Abstracts (ProQuest); Oceanic Abstracts (ProQuest); Oceanographic Literature Review (Elsevier); Physical Sciences Digest (CSA, Ebsco); Pollution Abstracts (ProQuest); Referativnyi Zhurnal; Science Citation Index; SciSearch (Thomson); SCOPUS; Water Resources Abstracts (Bethesda); Zoological Record (Thomson).

JOURNAL OF COASTAL RESEARCH

An International Forum for the Littoral Sciences

CHEF-HERAUSGEBER

EDITOR-IN-CHIEF Charles W. Finkl

RÉDACTEUR-EN-CHEF

Coastal Education and Research Foundation, Inc. [CERF] **Editorial Offices:**

5130 NW 54th Street Coconut Creek, FL 33073, U.S.A.

e-mail: cfinkl@cerf-jcr.com (Editorial Office, Coconut Creek) CERF/JCR Website: http://www.CERF-JCR.org

BOOK REVIEW EDITOR

J. Andrew G. Cooper School of Environmental Sciences University of Ulster Coleraine, N. Ireland jag.cooper@ulster.ac.uk

MANAGING EDITOR

Tracy Candelaria Allen Press Publishing Services 810 E. 10th Street Lawrence, KS 66044, U.S.A. tcandelaria@allenpress.com

PUBLISHING MANAGER

Christopher Makowski CERF 5130 NW 54th Street Coconut Creek, FL 33073, U.S.A. cmakowski@cerf-jcr.com

EDITORIAL ASSISTANT

Barbara Russell CERF 5130 NW 54th Street Coconut Creek, FL 33073, U.S.A. barbara@cerf-icr.com

MITHERAUSGEBER

Edward J. Anthony Coastal Geomorphology, Beach Morphodynamics Dunkerque, France

Cecile Baeteman Holocene Coastal Dynamics. Sea-Level Change Brussels, Belgium

Kenneth Banks Coral Reef Geomorphology. Habitat Mapping Plantation, Florida

Patrick Barnard Coastal Geomorphology Santa Cruz, California Lindino Benedet

Oceanography, Modeling Florianopolis, Santa Catarina, Brazil David M. Bush

Coastal Geology & Hazards Carrollton, Georgia Ilya V. Buynevich

Coastal Geology Philadelphia, Pennsylvania Javier A. Carrió

Sediment Processes, Marine Geology Valencia, Spain Paolo Ciavola

Coastal Engineering, Sediment Transport Ferrara, Italy

Mark Crowell Coastal Zone Management, Shoreline Change McLean, Virginia

Robert Dean Coastal Engineering & Processes Gainesville, Florida

Omar Defeo Sandy Beach Ecology, Invertebrates Montevideo, Uruguay

Reinhard Dieckman Coastal Engineering & Geomorphology Arnis/Schlei, Germany

Coastal Geomorphology Madrid, SpainJoseph F. Donoghue

J. Javier Diez

Coastal Morphology & Hazards Tallahassee, Florida Jean Ellis

Aeolian Sediment Transport Columbia, South Carolina

Michael S. Fenster

Shoreline Change, Barrier Island Morphodynamics Richmond, Virginia

Oscar Manuel Ferreira Storm Impacts, Beach Morphodynamics

Faro, Portûgal Duncan M. FitzGerald Sediment Transport, Numerical Modeling Boston, Massachusetts

Chip Fletcher Coastal Geology Honolulu, Hawaii

Kazimierz K. Furmańczyk Marine Cartography, Remote Sensing Szczecin, Poland

Gary B. Griggs Coastal Engineering & Hazards Santa Cruz, California

Pramod Hanamgond Coastal Geomorphology, Sedimentology

Belgaum, India Hans Hanson

Coastal Protection Numerical Modeling Lund, Sweden

Simon Haslett Paleoceanography, Coastal Evolution Wales, United Kingdom

Michael Hilton Dune Geomorphology & Ecology Dunedin, New Zealand

Carl H. Hobbs, III Coastal Geology, Sand Mining Gloucester Point, Virginia

James R. Houston

Sea-Level Change, Coastal Hydrodynamics Vicksburg, Mississippi

Wenrui Huang Coastal Hydrodynamics & Hazards Tallahassee, Florida

Michael G. Hughes Coastal Morphodynamics, Shelf Processes Canberra, ACT, Australia

Federico I. Isla Sea-Level Change, Remote Sensing Mar Del Plata, Argentina

Derek W.T. Jackson Aeolian Sediment Transport, Beach Morphodynamics Coleraine, Northern Ireland

ASSOCIATE EDITORS

Nancy L. Jackson Coastal Geomorphology Newark, New Jersey

Markes E. Johnson Paleoshores, Coastal Sand Dunes Williamstown, Massachusetts

Timothy R. Keen Waves & Circulation, Numerical Modeling Stennis Space Center, Mississippi

Dieter H. Kelletat Coastal Geomorphology, Sea-Level Change Essen/Cologne, Germany

Joseph T. Kelley Sea-Level Change, Salt Marsh Ecogeomorphology Orono, Maine

Syed Khalil Coastal Geology & Geophysics Baton Rouge, Louisiana Jack Kindinger

Oceanography, Coastal Resource Management St. Petersburg, Florida Antonio H.F. Klein

Coastal Morphodynamics & Florianópolis, Santa Catarina, Brazil

Vic Klemas Remote Sensing, Global Environmental Change Newark, Delaware

Nobuhisa Kobayashi Coastal Engineering Newark, Delaware

Vladimir N. Kosmynin Coral Reefs, Coastal Ecology Tallahassee, Florida

Joseph L. Kowalski Estuarine Plant Ecology Edinburg, Texas

Michael J. Lace Coastal Landforms & Processes West Branch, Iowa

Stephen P. Leatherman Barrier Islands, Beach Erosion Miami, Florida

Charles Lemckert Environmental Fluid Dynamics Queensland, Australia

Ioannis Liritzis Geophysical Proxy Data Rhodes, Greece

Jeffrey H. List Shoreline Change Processes Woods Hole, Massachusetts

Michel M. de Mahiques Sediment Process São Paulo, Brazil

Christopher Makowski Coastal Benthic Ecology, Marine Ecosystem Monitoring Coconut Creek, Florida

Ashish J. Mehta Coastal & Ocenographic Engineering Gainesville, Florida

Nobuo Mimura Global Environmental Engineering Ibaraki, Japan

Robert Nicholls Global Climate Change, Sea-Level Change Southampton, United Kingdom

Karl F. Nordstrom Coastal Geomorphology & Dune Processes New Brunswick, New Jersey

Julian Orford Gravel Beaches, Storm Events Belfast, Northern Ireland, UK Phil D. Osborne

Sediment Dynamics, Beach Morphodynamics Shoreline, Washington **Hugh Parker**

Airborne Lidar Bathymetry Adelaide, South Australia, Australia

Charitha B. Pattiaratchi Physical Oceanography Crawley, Western Australia, Australia

Carlos Pereira da Silva Coastal Zone Management Lisbon, Portugal

Michael Phillips

Coastal Geomorphology Swansea, Wales, United Kingdom Orrin H. Pilkey, Jr.

Coastal Geology Durham, North Carolina Paolo A. Pirazzoli

Sea-Level Changes Paris, France

Nobert P. Psuty Coastal Geomorphology New Brunswick, New Jersey

Ulrich Radtke Coastal Geomorphology Duisburg-Essen, Germany Elijah W. Ramsey, III

Coastal Image Proce Lafayette, Louisiana Kirt Rusenko

Sea Turtles, Dune Restoration Boca Raton, Florida

COMITÉ DE REDACTION

Andrew D. Short

Coastal Geomorphology, Beach Morphodynamics Sydney, New South Wales, Australia

Pravi Shrestha Coastal Engineering Irvine. California

Alejandro J. Souza Coastal & Sediment Processes Liverpool, United Kingdom

Tom Spencer Biogeomorphology, Wetland Morphodynamics Cambridge, United Kingdom

Marcel Stive Coastal Hydrodynamics, Sediment Dynamics $Delft, \, The \, \, \check{N}etherlands$

Vallam Sundar Coastal Engineering Chennai, India

Adam D. Switzer Coastal Hazards, Sea-Level Change

NTU, Singapore E. Robert Thieler

Marine Geology Woods Hole, Massachusetts Frank Van Der Meulen Coastal Zone Management.

Climate Change Delft, The Netherlands Ian J. Walker

Coastal Dunes, Sediment Transport Victoria, British Columbia, Canada

Ping Wang Beach Morphodynamics, Sediment Transport Tampa, Florida Allan Williams

Coastal Geology Swansea, Wales, United Kingdom Harry F. Williams

Hurricane Sedimentation. Paleotempestology Denton, Texas

Colin D. Woodroffe Coastal Geomorphology, Sea-Level Change Wollongong, Australia

Robert S. Young Coastal Processes & Management Cullowhee, North Carolina





THE JOURNAL OF COASTAL RESEARCH (JCR) (ISSN 0749–0208) IS PUBLISHED BIMONTHLY FOR \$115.00 FOR INDIVIDUAL US CERF MEMBERS, \$125.00 FOR INDIVIDUAL INTERNATIONAL CERF MEMBERS, \$519.00 FOR US INSTITUTIONS, AND \$541.00 FOR INTERNATIONAL INSTITUTIONS BY THE COASTAL EDUCATION AND RESEARCH FOUNDATION, INC. (CERF), 5130 NW 54TH STREET, COCONUT CREEK, FL 33073–3713. PERIODICALS POST-AGE PAID AT FORT LAUDERDALE, FL AND ADDITIONAL MAILING OFFICES. **POSTMASTER:** SEND ADDRESS CHANGES TO *JOURNAL OF COASTAL* RESEARCH, ALLEN PRESS ASSOCIATION MANAGEMENT, P.O. BOX 1897, LAWRENCE, KS 66044-3018.

© 2013 The Coastal Education & Research Foundation [CERF].

This paper meets the requirements of ANSI/NISO Z39.48-1992 (Permanence of Paper).

THE COASTAL EDUCATION AND RESEARCH FOUNDATION

5130 NW 54th Street Coconut Creek, FL 33073, U.S.A.

Officers of the Foundation

Founded in 1983 by: Charles W. Finkl, Sr., Charles W. Finkl, Jnr., Rhodes W. Fairbridge, and Maurice L. Schwartz

President & Executive Director: Charles W. Finkl Senior Vice President & Assistant Director: Christopher Makowski

 Vice President:
 Secretary:
 Executive Assistant:

 Syed Khalil
 Heather M. Vollmer
 Barbara Russell

Board of Directors (Trustees)

J. Andrew G. Cooper Robert Dean Charles W. Finkl Gary B. Griggs James R. Houston Robert Huff Joseph T. Kelley

Victor Klemas Charles Lemckert Christopher Makowski Michael Phillips Orrin H. Pilkey, Jr. Norbert P. Psuty Elijah W. Ramsey, III Maurice L. Schwartz Andrew D. Short Daniel J. Stanley Marcel Stive Allan Williams

Lifetime Members

Yong-Sik Cho Charles Lemckert Nicholas K. Coch Ya Ping Wang

Patron Members

Luis Antonio Buenfil-Lopez Georges Chapalain Mark Crowell Carl H. Hobbs, III Timothy W. Kana Bedoor Adel Mohammad Norbert P. Psuty Giovanni Randazzo Harley Winer Robert S. Young

The Coastal Education and Research Foundation [CERF] is a nonprofit society dedicated to the advancement of the coastal sciences. The Foundation is devoted to the multi-disciplinary study of the complex problems of the coastal zone. The purpose of CERF is to help translate and interpret coastal issues for the public and to assist professional research and public information programs. The Foundation specifically supports and encourages field and laboratory studies on a local, national, and international basis. Through the medium of scientific publications, television, and radio CERF brings accurate information to the public and coastal specialists on all aspects of coastal issues in an effort to maintain or improve the quality of shoreline resources.

Because CERF is concerned with broad environmental issues, our efforts concentrate on significant problems such as maintenance of good quality (potable) water with adequate supply, and hazards associated with potential beach erosion, flooding, and susceptibility of developed shorelines to storm surge and wave attack. By focusing attention on these potential man-made and natural hazards, it is hoped that our research efforts will help others improve the quality of life in diverse coastal areas. CERF thus aims to stimulate awareness of coastal (marine and freshwater shorelines) land and water problems; initiate and foster research and innovation to promote long-term coastal productivity; establish an educational forum for the debate of contentious coastal issues; and develop new principles and approaches for enlightened coastal management, and encourage their adoption and use.



\square CERF MEMBERSHIP \square

Members are individuals that support the aims of the foundation through personal and group efforts or by donations. Memberships are available in different categories with privileges.

Subscription information is available online at www.cerf-jcr.org. Subscriptions office: Allen Press, Inc., P.O. Box 1897, Lawrence, KS 66044, U.S.A. CERF@allenpress.com

Editor-in-Chief

Charles W. Finkl Ph.D., CSci, CMarSci, FIMarEST, CPGS, CPSSc, PWS

Dr. Charles W. Finkl is President and Executive Director of the Coastal Education & Research Foundation (CERF), publisher of the JCR. Charlie, a founding editor of the Journal of Coastal Research, has served as Editor-in-Chief for the past 27 years. He is a Research Professor in the Department of Geosciences at Florida Atlantic University in Boca Raton, Florida. He received his Bachelor and Master of Science degrees from Oregon State University and the Ph.D. from the University of Western Australia. He is a member of more than 20 professional societies and has published more than 200 professional papers, books, and reports. He is a Chartered Marine Scientist (CMarSci) [Institute of Marine Engineering, Science and Technology], Certified Professional Geological Scientist (CPGS) [American Institute of Professional Geologists (AIPG),], Certified Professional Soil Scientist (CPSSc) [American Registry of Certified Professionals in Agronomy, Crops, and Soils], and a Professional Wetland Scientist (PWS) [Society of Wetland Scientists]. Charlie has field experience in parts of the USA, Caribbean area, Brazil, Honduras, Russia, South Africa, Western Europe, Australasia, and South Pacific islands. He is also the Series Editor of the Encyclopedia of Earth Sciences Series that is published by Springer (Germany). There are more than twentyeight volumes in the Series and about twenty-five are available online. Charlie also serves on the Editorial Board of the International Journal of Environmental Studies (Routledge) and is an occasional peer reviewer for many other professional journals.

Charlie has interests and expertise in the general areas of surficial geology, coastal and marine geomorphology (including coastal classification), coastal/marine biophysical environments, exploration geochemistry, soils and weathering (regolith geology), coastal zone management and engineering applications or impacts on natural systems (including erosion control and shore protection), coastal hydrology including submarine freshwater and mineralized seeps, subaerial and marine structural geology, natural hazard mitigation in coastal zones, marine environments and coastal wetland protection and restoration, and remote sensing (e.g. land cover classification in coastal wetlands, advection-diffusion turbidity plumes in coastal waters, delineation of bottom types and sand resources), effluent disposal and pollution of wetlands and estuaries, water resources mapping and conservation, time series studies of wetland hydroperiod and soil moisture.

CERF Foundation Meetings International Coastal Symposiums (ICS)

The International Coastal Symposium (ICS) was originally set up by Per Bruun (deceased) and Charlie Finkl as the official meeting of the Coastal Education & Research Foundation (CERF), with the first meeting being held in Hilton Head, South Carolina, in 1993. After the repeated success of these meetings, CERF moved the ICS to the international scene holding these conferences in conjunction with local sponsors in Australia, Brazil, Iceland, New Zealand, Northern Ireland, Poland and Portugal. The ICS brings together delegates from all over the world to collaborate and discuss the most current coastal research studies and projects. The ICS 2014, which is scheduled to be held from April 13–17 in Durban, South Africa, will be a grand celebration of CERF and the JCR, marking the 30th Anniversary for both. For more information, please visit www.cerf-jcr.org.