

# Ecological Restoration

Volume 37 ■ Number 3 | September 2019



**Making tracks: tortoise habitat during dune restorations**

**IN MEMORY OF ERIN K. ESPELAND**

*Myla F.J. Aronson*

**EDITORIAL**

The Living Dead and the Practice of Landscape Restoration

*Steven N. Handel*

**RESTORATION NOTES**

Caloric Values of Selected Wetland and Coastal Sage Scrub Vascular Plant Seeds

*Peter A. Bowler, Jenny Liou and Jocelyn Moon*

Promoting Change in Common Tern (*Sterna hirundo*) Nest Site Selection to Minimize Construction Related Disturbance

*Peter C. McGowan, Jeffery D. Sullivan, Carl R. Callahan, William Schultz, Jennifer L. Wall and Diann J. Prosser*

Mycorrhizae and root morphology in potted and wild *Artemisia californica* and *Eriogonum fasciculatum*

*Christopher.M. Gunawan and Peter A. Bowler*

**ARTICLES**

Arbuscular Mycorrhizal Fungi in the Rhizosphere of Saplings Used in the Restoration of the Rupestris Grassland

*Etiene Silva Coutinho, Wallace Beiroz, Milton Barbosa, João Henrique de Azevedo Xavier and G. Wilson Fernandes*

Five Decades of Wetland Soil Development of a Constructed Tidal Salt Marsh, North Carolina, USA

*Aaron Noll, Courtney Mobilian, and Christopher Craft*

An Adaptive Managed Retreat Approach to Address Shoreline Erosion at the Kennedy Space Center, Florida

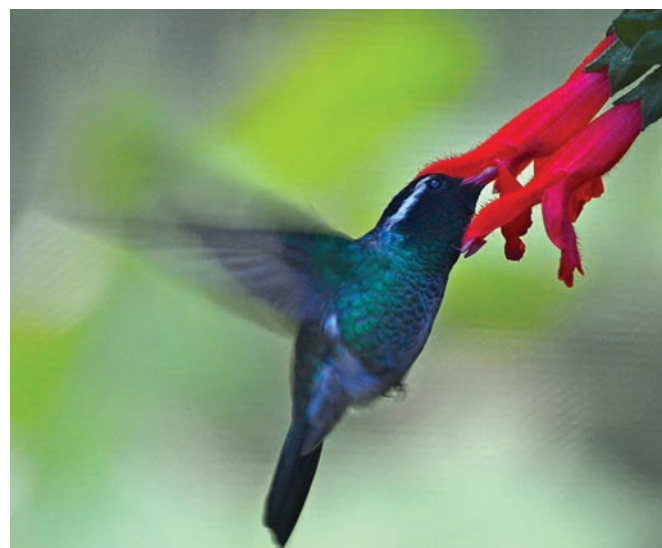
*M. Rebecca Bolt, Mark A. Mercadante, Timothy J. Kozusko, Stephanie K. Weiss, Carlton R. Hall, Jane A. Provancha, Naresa R. Cancro, Tammy E. Foster, Eric D. Stolen, Scott A. Martin*

Restoration of Society-Nature Relationship Based on Education: A Model and Progress in Patagonian Drylands

*Daniel Roberto Pérez, Florencia del Mar González, María Emilia Rodríguez Araujo, Daniela Ailín Paredes and Elsa Meinardi*

Biocultural Species Enhancement in the Archaeological Site of Tzintzuntzan, the “Place of Hummingbirds”

*Marina Barajas-Arroyo, Brenda Brown, José Luis Punzo, Jorge E. Schondube, Ian MacGregor-Fors and Roberto Lindig-Cisneros*



**FSC Certification Logo here**

# Ecological Restoration

Volume 37, Number 3



September 2019

**In Memory of Erin K. Espeland** 139  
*Myla F.J. Aronson*

**Editorial** 140  
The Living Dead and the Practice of Landscape Restoration  
*Steven N. Handel*

## RESTORATION NOTES

Caloric Values of Selected Wetland and Coastal Sage Scrub Vascular Plant Seeds 142  
*Peter A. Bowler, Jenny Liou and Jocelyn Moon*

Promoting Change in Common Tern (*Sterna hirundo*) Nest Site Selection 143  
to Minimize Construction Related Disturbance  
*Peter C. McGowan, Jeffery D. Sullivan, Carl R. Callahan, William Schultz, Jennifer L. Wall and Diann J. Prosser*

Mycorrhizae and Root Morphology in Potted and Wild *Artemisia californica* and *Eriogonum fasciculatum* 148  
*Christopher.M. Gunawan and Peter A. Bowler*

## ARTICLES

Arbuscular Mycorrhizal Fungi in the Rhizosphere of Saplings Used 152  
in the Restoration of the Rupestris Grassland  
*Etiene Silva Coutinho, Wallace Beiroz, Milton Barbosa, João Henrique de Azevedo Xavier and G. Wilson Fernandes*

Five Decades of Wetland Soil Development of a Constructed Tidal Salt Marsh, North Carolina, USA 163  
*Aaron Noll, Courtney Mobilian, and Christopher Craft*

An Adaptive Managed Retreat Approach to Address Shoreline Erosion 171  
at the Kennedy Space Center, Florida  
*M. Rebecca Bolt, Mark A. Mercadante, Timothy J. Kozusko, Stephanie K. Weiss, Carlton R. Hall, Jane A. Provanha, Naresa R. Cancro, Tammy E. Foster, Eric D. Stolen and Scott A. Martin*

Restoration of Society-Nature Relationship Based on Education: 182  
A Model and Progress in Patagonian Drylands  
*Daniel Roberto Pérez, Florencia del Mar González, María Emilia Rodríguez Araujo, Daniela Ailín Paredes and Elsa Meinardi*

Biocultural Species Enhancement in the Archaeological Site of Tzintzuntzan, 192  
the “Place of Hummingbirds”  
*Marina Barajas-Arroyo, Brenda Brown, José Luis Punzo, Jorge E. Schondube, Ian MacGregor-Fors and Roberto Lindig-Cisneros*

## ABSTRACTS

Climate Change	199	Propagation & Introduction	202
Coastal & Marine Communities	199	Reclamation, Rehabilitation, & Remediation	203
Ecological Design	200	Species at Risk	203
Economics & Ecosystem Services	200	Technology & Tools	203
Grasslands	201	Traditional and Local Knowledge	204
Invasive & Pest Species	201	Urban Restoration	204
Lakes, Rivers, & Streams	201	Wetlands	204
Monitoring & Adaptive Management	202	Wildlife Habitat Restoration	204
Planning and Policy	202	Woodlands	205

## MEETINGS

206



### Erratum for Vol. 37, No. 1, 2019

For the front cover image, the photo was incorrectly labeled as being located in Minnesota, but should have been labeled as a site in Illinois. We apologize for any inconvenience.

**Front Cover Feature:** Since 1999, erosion along the Kennedy Space Center coastline in Florida has increased as a result of frequent storm surges. To protect valuable national assets and infrastructure at the site, a system of created dunes has been installed. In a case study, Bolt et al. document how these created dunes have benefitted two protected wildlife species: *Gopherus polyphemus* (gopher tortoise, whose footprints are pictured here) and *Peromyscus polionotus niveiventris* (southeastern beach mouse). Image credit: Rebecca Bolt

### Back Cover Features:

Top: Marshes are often nitrogen limited even though sufficient nitrogen (N) and carbon (C) are critical to sustain plant productivity and support biogeochemical processes such as decomposition and denitrification in these systems. Noll et al. examined the development of wetland soils over five decades in a constructed salt marsh. Their findings help restoration ecologists identify target soil properties such as bulk density, C, N, and C:N, for gauging wetland restoration success and estimating the time frame necessary for recovery. Image credit: Christopher Craft.

Middle: In the arid and semiarid regions of Patagonia, Argentina, millions of hectares have been desertified by cattle ranching and hydrocarbon extraction activities. Restoring habitat in this region is a large undertaking that requires cooperation among diverse landholders. Through a case study, Pérez et al. present a multi-step and multi-year model for Environmental Education (EE) developed to engage stakeholders in ecological restoration. As a result of the EE process, residents worked cooperatively with government and industry to establish native species nurseries and revegetate degraded lands. Image credit: Daniel Pérez.

Bottom: Biocultural restoration aims to reestablish both the ecological and cultural components at a site. Hummingbirds have been a culturally relevant wildlife group in Mexico since pre-Columbian times but are absent from many cultural heritage sites due to ecological degradation. To help re-establish a connection between people and their cultural and natural heritage, Barajas-Arroyo et al. conducted biocultural species enhancement at an archaeological site. They report on vegetation parameters necessary to attract target hummingbird species, and document how this enhancement has impacted visitor experiences at the site. Image credit: Roberto Lindig-Cisneros

## EDITORIAL BOARD

### Scott Abella

Natural Resource Conservation LLC,  
Boulder City, USA.

### Steven I Apfelbaum

Applied Ecological Services, Wisconsin, USA.

### James Aronson

Center for Conservation and Sustainable  
Development, Missouri Botanical Garden,  
St. Louis MO, USA.

### Myla Aronson

Department of Ecology, Evolution and  
Natural Resources, Rutgers University NJ, USA.

### Paulette Bierzychudek

Department of Biology, Lewis & Clark College,  
Portland OR, USA.

### Peter Bowler

Department of Ecology and Evolutionary  
Biology, University of California, Irvine, USA.

### Lindsay Campbell

USDA Forest Service Northern Research Station,  
NY, USA.

### Robin L. Chazdon

Department of Ecology and Evolutionary  
Biology, University of Connecticut, USA.

### Francisco A. Comín Sebastián

Pyrenean Institute of Ecology-CSIC, Spain.

### David Drake

Department of Forest and Wildlife Ecology,  
University of Wisconsin–Madison, USA.

### Bram Gunther

New York City Urban Field Station, New York  
City Department of Parks & Recreation, Bayside,  
New York, USA.

### Jason Hall

National Oceanic and Atmospheric Administration's  
Northwest Fisheries Science Center Mukilteo  
Research Station, Seattle WA, USA.

### Emily Huff

Department of Forestry, Michigan State  
University East Lansing MI, USA.

### Francine Hughes

Department of Life Sciences,  
Anglia Ruskin University, Cambridge, UK.

### Basil Iannone

School of Forest Resources and Conservation,  
University of Florida, Gainesville FL, USA.

### Michelle Johnson

New York City Urban Field Station, USDA Forest  
Service, Bayside, New York, USA.

### Holly Jones

Department of Biological Sciences,  
Northern Illinois University, USA.

### Kristen Kaczynski

Department of Geological and Environmental  
Sciences at California State University, Chico  
CA, USA.

### Kristy King

Natural Areas Restoration & Management  
Forestry, Horticulture & Natural Resources,  
New York City Department of Parks &  
Recreation, Long Island City, New York, USA.

### Márcia C.M. Marques

Department of Botany, Universidade Federal do  
Paraná, Curitiba, Brazil.

### David Moreno-Mateos

Basque Center for Climate change–BC3,  
Basque Country, Spain.

### Andrew Rayburn

Independent Consulting Ecologist, Davis, USA.

### Carrie Reinhardt Adams

Environmental Horticulture Department,  
University of Florida, Gainesville, USA.

### David J. Robertson

Livermore, CO, USA

### Ted Shear

Department of Forestry and Environmental  
Resources, North Carolina State University,  
Raleigh NC, USA.

### Greg Spyreas

Illinois Natural History Survey, USA.

### Katharine Suding

Department of Ecology & Evolutionary Biology,  
University of Colorado Boulder CO, USA.

### Alan Unwin

School of Environmental and Horticultural  
Studies, Niagara College, Canada.

### Dennis Whigham

Smithsonian Environmental Research Center,  
USA.

### Ken Yocom

Department of Landscape Architecture,  
University of Washington, USA.

### Kathryn Yurkonis

Department of Biology, University of North  
Dakota, Grand Forks, North Dakota, USA.

### Luis Zambrano González

Biology Institute, National Autonomous  
University of Mexico (UNAM), Mexico.

## JOURNAL STAFF

**Editor:** Steven N. Handel

**Associate Editor:** Tabby Fenn

**Managing Editor:** Paulina A. Arancibia

**Abstracts Editor:** Elena S. Tartaglia

**Abstracts Contributors:** Elena S. Tartaglia and  
Paulina A. Arancibia

Rutgers, The State University of New Jersey

School of Environmental and Biological

Sciences: *Robert M. Goodman, Executive Dean*

Society for Ecological Restoration: *Jim Hallett,*  
*Chair*



Printed on 30% recycled text paper.

*Ecological Restoration* is published quarterly by the University of Wisconsin Press. © by the Board of Regents of the University of Wisconsin System. No part of this publication may be reproduced without the written consent of the publisher, University of Wisconsin Press. Requests for permission to reprint an article or illustration should be made directly to UW Press, 728 State Street, Suite 443, Madison, WI 53706-1428, [permissions@uwpress.wisc.edu](mailto:permissions@uwpress.wisc.edu), [er.uwpress.org](http://er.uwpress.org).

Contributions are welcome. Authors should upload their materials through *Ecological Restoration's* submission website, which can be found at [er.uwpress.org](http://er.uwpress.org). Submission guidelines can be found at [uwpress.wisc.edu/journals/journals/er\\_submissions.html](http://uwpress.wisc.edu/journals/journals/er_submissions.html).

Authorization to reproduce material from this journal, beyond one copy for personal use or that permitted by Sections 107 and 108 of U.S. Copyright Law, is granted for a fee. For fee schedule and payment information, contact [www.copyright.com](http://www.copyright.com); The Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, 978/750-8400, Fax: 978/750-4470.

*Ecological Restoration* is indexed in Elsevier BIOBASE, AGRICOLA, and in CSA's Ecology databases.

*Ecological Restoration* is affiliated with the Society for Ecological Restoration, 1017 O St. NW, Washington, DC 20001, 202/299-9518, [ser.org](http://ser.org). Members of the Society for Ecological Restoration receive *Ecological Restoration* at a discounted rate. Please visit the UW Press Web site at [uwpress.wisc.edu/journals](http://uwpress.wisc.edu/journals) for more information.

*Ecological Restoration* was founded at the University of Wisconsin–Madison Arboretum.

**Advertising:** Call 608/263-0534 for current rates. Advertisements or references to products by brandname or trademark do not imply an endorsement by the editors or publishers of this journal.

*Ecological Restoration* (ISSN 1522-4740, E-ISSN 1543-4079) is published quarterly by the University of Wisconsin Press, 728 State Street, Suite 443, Madison, WI 53706-1428. Periodicals postage paid at Madison WI and at additional mailing offices.

**Subscriptions:** Individual (please pre-pay), \$82 print and electronic, \$70 electronic only; \$41 students; \$210 businesses and nongovernmental organizations; libraries and government agencies, \$310 print and electronic, \$285 electronic only. Non-U.S. subscribers please add \$40 for foreign shipping. All correspondence regarding subscriptions, advertising, and related matters should be sent to Journals Division, 728 State Street, Suite 443, Madison, WI 53706-1428, USA; [uwpress.wisc.edu/journals](http://uwpress.wisc.edu/journals). Members of the Society for Ecological Restoration receive *Ecological Restoration* at a discounted rate.

Please visit our Web site at [uwpress.wisc.edu/journals](http://uwpress.wisc.edu/journals) for more information.

**POSTMASTER:** Send address changes to *Ecological Restoration*, 728 State Street, Suite 443, Madison, WI 53706-1428.

## Submissions

We welcome submissions to *Ecological Restoration* from any part of the world. Submissions should relate to the restoration of plants, animals, ecological communities, or landscapes. We understand ecological restoration to be a multidisciplinary and diverse effort and welcome manuscripts considering ecological, and social aspects of restoration, as well as political, economic, legal, and regulatory issues, and other subjects related to ecological restoration. Relevant topics also include techniques and tools for planning, site preparation, species introduction, undesired species control, and monitoring. Manuscripts dealing with plant or animal community composition or general ecology must relate the work explicitly to ecological restoration practice and theory. Similarly, material dealing with reclamation or rehabilitation in a broader sense, or with restoration for economic purposes—economic forestry, range management, waste disposal—must be connected to ecological restoration.

Material may be submitted for the following categories (listed as they are encountered in the Journal):

1. Perspectives
2. Restoration Notes (shorter items, < 1500 words describing project updates, events, innovative technologies, preliminary or unusual findings, thought-provoking concepts, imaginative solutions, commentary, policy reports, etc.)
3. Research articles or reviews on ecological restoration theory, experiments, socio-ecological linkages, education, restoration history, practice
4. Case studies (full length articles describing a particular restoration project or location and lesson learned)
5. Book, journal, website, or movie reviews

Authors of full-length articles or reviews should submit their material online at [er.msubmit.net](http://er.msubmit.net). Manuscripts must be submitted with a cover letter stating that the material has not been previously published, and has not been submitted elsewhere and will not be until a final decision has been reached by the editor. Questions about the online submission site, or general inquiries may be emailed to [ERjournal@sebs.rutgers.edu](mailto:ERjournal@sebs.rutgers.edu).

## Review and Editing Process

Manuscripts are reviewed externally by experts in the field. The process requires approximately four to six months. Restoration Notes are reviewed and edited in-house unless additional expertise is required to evaluate the submission.

## Style

Practitioners of ecological restoration are both a core audience and source of contributions to *ER*. Contributors should use a straightforward style free of unnecessary technical terms and jargon. We prefer the active voice (for example, “We measured three trees” instead of “Three trees were measured”). Please see our Submission Guidelines at [er.uwpress.org](http://er.uwpress.org) for more information.

## Tables, Photos, and Illustrations

Table and Figure captions should include useful and detailed information, and should be independent of the text. Figures will be reproduced in black and white in the print version of *Ecological Restoration* (usually requiring higher contrast) and can be reproduced in color in the online version. We use color photos on the front and back covers of the journal and welcome submissions of eye-catching, informative, high-quality photographs.

## Page Charges

Payment of \$50 per page is requested from authors with research grant or other institutional funds available to underwrite publication costs. Invoices will be sent after composition of pages. Authors with no grant or institutional funds do not need to pay publication costs. Ability to pay page charges is not a condition for acceptance of a manuscript.