



# BioOne COMPLETE

---

## Cover

Source: The Condor, 117(4)

Published By: American Ornithological Society

URL: <https://doi.org/10.1650/cond.2015.117.4.cov>

---

BioOne Complete ([complete.BioOne.org](https://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](http://www.bioone.org/terms-of-use).

---

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

## Mission and Scope

*The Condor: Ornithological Applications* is an international, peer-reviewed journal that publishes original research, syntheses, and assessments that address ornithological applications in two ways: the application of scientific theory and methods to the conservation, management, and ecology of birds; and the application of ornithological knowledge to conservation and management policy and other issues of importance to society. The journal aims to reach both research ornithologists and practitioners.

Topics addressed in the journal include:

- Population biology, including threats to bird populations
- Conservation genetics
- Community and landscape ecology
- Ecosystem-level influences of birds
- Effects of habitat alteration and fragmentation
- Avian responses to climate change
- Anthropogenic effects on genetics, behavior, or physiological processes
- Biology of avian diseases and disease transmission by birds
- Birds in urban or agricultural settings
- Sociological and economic studies related to birds or the discipline of ornithology
- Integrative and cross-disciplinary studies
- Theoretical and methodological advances in practice
- Evaluations of science relevant to issues in conservation and management
- Thematic reviews and opinion pieces

## Joint Publishing Venture

The Cooper Ornithological Society and the American Ornithologists' Union have redefined and are jointly publishing their peer-reviewed, international journals of ornithology beginning in 2014. *The Condor* has become *The Condor: Ornithological Applications* and focuses on applied ornithological study. *The Auk* has become *The Auk: Ornithological Advances* and focuses on basic ornithological science. The redefined missions create an opportunity for the journals to work together to publish the best science in applied and basic ornithology and to build on their long histories as top journals in the field of avian biology.

*The Condor: Ornithological Applications* and *The Auk: Ornithological Advances* are managed by the Central Ornithology Publication Office (COPO), the joint publication management office of the Cooper Ornithological Society and the American Ornithologists' Union.



# THE CONDOR

# Ornithological Applications

Volume 117 Number 4 November 2015



THE CONDOR: Ornithological Applications

Volume 117, Number 4, Pages 485-694

November 2015

Editor-in-Chief: Philip C Stouffer

Jointly published by the Cooper Ornithological Society and the American Ornithologists' Union



# THE CONDOR

---

# Ornithological Applications



## COOPER ORNITHOLOGICAL SOCIETY

### EDITOR-IN-CHIEF Philip C Stouffer

School of Renewable Natural Resources, Louisiana State University, pstouffer@lsu.edu

**EDITORS** Paul F. Doherty, Jr., Colorado State University, paul.doherty@colostate.edu  
Colleen M. Handel, USGS Alaska Science Center, cmhandel@usgs.gov

**Managing Editor:** Kathleen E. Erickson, aoucospubs@gmail.com, (415) 435-1604

**Assistant Managing Editor:** Mark C. Penrose, aoucospubs@gmail.com

**Copyeditors:** Richard Earles, Janice Faaborg, Scott W. Gillihan, Thalia Sachtleben

**Abstract Translators:** Carlos Daniel Cadena Ordoñez, Jessica Eberhard, Lucio R. Malizia, Karl S. Mokross, Hélène Senechal

### ASSOCIATE EDITORS

Jane E. Austin, USGS Northern Prairie Wildlife Research Center

Justin D. Brown, The University of Georgia

Richard Buchholz, University of Mississippi

Jeffrey J. Buler, University of Delaware

Kristina L. Cockle, Louisiana State University

Norbert J. Cordeiro, The Field Museum

Jim Cox, Tall Timbers Research Station

Amy J. Davis, USDA APHIS

Jill L. Deppe, Eastern Illinois University

R. J. Gutiérrez, University of Minnesota

Amanda M. Hale, Texas Christian University

Mark D. Jankowski, Minnesota Pollution Control Agency

Steven T. Knick, USGS Forest and Rangeland Ecosystem

Science Center

Richard B. Lanctot, USFWS Alaska Region

Steven C. Latta, National Aviary

Matthias Leu, College of William and Mary

Martine Maron, The University of Queensland

Kathy Martin, The University of British Columbia

Daniel J. Mennill, University of Windsor

Joseph J. Nocera, Ontario Ministry of Natural Resources

Erica Nol, Trent University

Jennifer C. Owen, Michigan State University

Susan Smith Pagano, Rochester Institute of Technology

Monica Papeş, Oklahoma State University

A. Townsend Peterson, The University of Kansas

Christin L. Pruett, Florida Institute of Technology

Gregory J. Robertson, Environment Canada Wildlife Research Division

Victoria A. Saab, USFS Rocky Mountain Research Station

Sarah A. Sonsthagen, USGS Alaska Science Center

David Swanson, University of South Dakota

Diana F. Tomback, University of Colorado Denver

Steven L. Van Wilgenburg, Environment Canada National Hydrology

Research Centre

Eric A. VanderWerf, Pacific Rim Conservation

Gustavo A. Zurita, Universidad Nacional de Misiones—CONICET

**Book Review Editor:** Jay Mager, Ohio Northern University, j-mager@onu.edu

**In Memoriam Editor:** Lloyd Kiff, lkiff2@msn.com

**On the Cover:** Foraging adult Red Knots (*Calidrus canutus rufa*) during spring migration at Slaughter Beach, Delaware, USA (see McGowan, in this issue, pp. 494–502). Photo credit: Conor P. McGowan

**Journal Information:** *The Condor: Ornithological Applications* publishes original research, syntheses, and assessments that address ornithological applications in two ways: the application of scientific theory and methods to the conservation, management, and ecology of birds; and the application of ornithological knowledge to conservation and management policy and other issues of importance to society. Appropriate topics include documentation, analysis, and interpretation of laboratory and field studies; theoretical or methodological advances in practice; and reviews of information or ideas. Contributions are welcomed from around the world but must be written in English. The articles in this journal reflect the research and opinions of the individual authors. *As such, the articles do not necessarily reflect the opinions of the editors or any official policy of the Cooper Ornithological Society or the American Ornithologists' Union.*

**Submit manuscripts** online at [www.editorialmanager.com/condor](http://www.editorialmanager.com/condor). **Author instructions** are at [www.aoucospubs.org/page/instructions](http://www.aoucospubs.org/page/instructions).

**Copying and permissions notice:** Persons seeking to obtain rights and permission to reprint papers, figures, tables, etc., or parts thereof, previously published in *The Condor* and *The Condor: Ornithological Applications* should contact the Central Ornithology Publication Office (COPO) at [aoucospubs@gmail.com](mailto:aoucospubs@gmail.com).

**Abstracting and indexing:** Articles appearing in *The Condor: Ornithological Applications* are abstracted and indexed in the databases listed online at [www.aoucospubs.org/page/mission](http://www.aoucospubs.org/page/mission).



*The Condor: Ornithological Applications* (ISSN 0010-5422, e-ISSN 1938-5129) is published online weekly by the Cooper Ornithological Society and the American Ornithologists' Union at [www.aoucospubs.org](http://www.aoucospubs.org). Periodicals postage paid at Waco, TX and at additional mailing offices. POSTMASTER: Send address changes to *The Condor: Ornithological Applications*, OSNA Business Office, 5400 Bosque Blvd., Suite 680, Waco, TX 76710; [business@osnabirds.org](mailto:business@osnabirds.org). Printed quarterly by Allen Press on Forest Stewardship Council® certified paper.

### OFFICERS AND EDITORS

**President:** Martin G. Raphael, USDA Forest Service, Pacific Northwest Research Station, 3625 93rd Ave. SW, Olympia, WA 98512, [mraphael@fs.fed.us](mailto:mraphael@fs.fed.us)

**President-Elect:** Anna D. Chalfoun, Department of Zoology & Physiology, University of Wyoming, Laramie, WY 82071, [achalfou@uwyo.edu](mailto:achalfou@uwyo.edu)

**Past-President:** Frank R. Moore, Department of Biological Sciences, University of Southern Mississippi, Hattiesburg, MS 39406, [frank.moore@usm.edu](mailto:frank.moore@usm.edu)

**Treasurer:** Barbara Kus, U.S. Geological Survey, Western Ecological Research Center, San Diego Field Station, San Diego, CA 92101, [barbara\\_kus@usgs.gov](mailto:barbara_kus@usgs.gov)

**Assistant Treasurer:** Mary Whitfield, Southern Sierra Research Station, Weldon, CA 93283

**Secretary:** Abby N. Powell, U.S. Geological Survey, Alaska Cooperative Fish and Wildlife Research Unit, Fairbanks, AK 99775, [abby.powell@alaska.edu](mailto:abby.powell@alaska.edu)

**Assistant Secretary:** Joseph J. Fontaine, 3701 Apple Street, Lincoln, NE 68503, [fontaine.joseph@gmail.com](mailto:fontaine.joseph@gmail.com)

**Editor-in-Chief of *The Condor: Ornithological Applications*:** Philip C Stouffer, School of Renewable Natural Resources, Louisiana State University, Baton Rouge, LA 70803, [pstouffer@lsu.edu](mailto:pstouffer@lsu.edu)

**Editor of *Studies in Avian Biology*:** Kate Huyvaert, Colorado State University, Warner College of Natural Resources, Fort Collins, CO 80523, [Kate.Huyvaert@colostate.edu](mailto:Kate.Huyvaert@colostate.edu)

### BOARD OF DIRECTORS

2013–2016: Alice Boyle, Kevin J. McGraw, John T. Rotenberry

2014–2017: Jill Deppe, Jeff Kelly, Matt Johnson

2015–2018: Jen C. Owen, Morgan Tingley, Blair Wolf

### LIVING PAST PRESIDENTS

Frank R. Moore (2013–2015), Kimberly A. Sullivan (2011–2013), Mercedes S. Foster (2009–2011), Thomas E. Martin (2007–2009), John T. Rotenberry (2005–2007), Bonnie S. Bowen (2003–2005), Terry Rich (2001–2003), Glenn Walsberg (1999–2001), J. Michael Scott (1997–1999), Sheila Mahoney (1995–1997), Lloyd Kiff (1993–1995), Martin L. Morton (1991–1993), Jared Verner (1989–1991), Russell P. Balda (1987–1989), C. John Ralph (1985–1987), Dennis Power (1978–1981), Stephen M. Russell (1976–1978)

### MEMBERSHIP

Any person interested in avian biology may become a member of the Cooper Ornithological Society. Regular membership costs \$45 per year; student memberships are \$25. Membership is \$25 for persons in all countries except the United States, Canada, Israel, Japan, Australia, New Zealand, and the following Western European countries: Iceland, Norway, Sweden, Finland, Denmark, Germany, The Netherlands, Belgium, Luxembourg, France, the United Kingdom, Ireland, Switzerland, Austria, Italy, Spain, and Portugal. All members receive access to the online version of *The Condor: Ornithological Applications* and the bimonthly *Ornithological Newsletter*. Quarterly print versions of *The Condor: Ornithological Applications* can be ordered by members for \$40/year. A life membership is \$1,000, paid in one sum or four annual installments of \$250. Individuals may join, renew memberships, and report changes of address through the Ornithological Societies of North America (OSNA): [www.osnabirds.org](http://www.osnabirds.org); [business@osnabirds.org](mailto:business@osnabirds.org); 5400 Bosque Blvd., Suite 680, Waco, TX 76710. Gifts to the Cooper Society are tax-deductible to the extent permitted by law.

### INSTITUTIONAL SUBSCRIPTIONS

The Ornithological Societies of North America (OSNA) handles institutional subscriptions: (254) 399-9636, [business@osnabirds.org](mailto:business@osnabirds.org). See [www.osnabirds.org](http://www.osnabirds.org) for single-issue and subscription orders, claims information, and mail dates. Domestic claims for nonreceipt of issues should be made within 90 days of the mail date; overseas claims within 180 days.