# STAILSIZAL SUMMER

a review journal of the institute of mathematical statistics

Volume 3

Number 3

August 1988

**Featuring** 

Articles from the

NINTH SYMPOSIUM

ON

**STATISTICS** 

AND THE

**ENVIRONMENT** 

Risk Assessment and Public Policy:

A Forum for Interdisciplinary Interaction

### **EXECUTIVE EDITOR**

Morris H. DeGroot Carnegie Mellon University

### **EDITORIAL ASSISTANT**

Tina Lynne Rees

### **EDITORS**

Ingram Olkin Stanford University Stephen Stigler University of Chicago James V. Zidek University of British Columbia

### MANAGING EDITOR

Paul Shaman University of Pennsylvania

### **EDITORIAL ASSISTANT**

Tammy Morrow

The aim of Statistical Science is to present the full range of contemporary statistical thought at a technical level accessible to the broad community of practitioners, teachers, researchers, and students of statistics and probability.

The journal will publish discussions of methodological and theoretical topics of current interest and importance, surveys of substantive research areas with promising statistical applications, comprehensive book reviews, discussions of classic articles from the statistical literature, and interviews with distinguished statisticians and probabilists.

### SUBMISSION POLICY

Statistical Science welcomes the submission of expository, review, and survey papers in all areas of the theory, methodology, and applications of statistics and probability. Articles that synthesize research that has been published in diverse sources or that has been developed from diverse points of view are especially valuable.

Four nonreturnable copies of any manuscript submitted for consideration are requested for the reviewing process. Effective immediately copies should be mailed first class to:

Professor Carl N. Morris
Executive Editor, Statistical Science
Statistical Sciences Center, RLM 8.100
University of Texas
Austin, TX 78712

The manuscripts should be typed on  $8\frac{1}{2} \times 11$ -inch white paper, on one side only, and double-spaced throughout, including the references, with margins of at least  $1\frac{1}{2}$  inches on all four sides. Pages should be numbered consecutively. The manuscript should contain an abstract of 200 or fewer words, followed by approximately 5 or 6 key words or phrases. A short author's note providing the name, address, present position or rank, and affiliation of each author should also be included.

A condition of submission is that the manuscript has not previously been published and is not simultaneously being considered for publication elsewhere.

Statistical Science is copyrighted and authors will be asked to sign a copyright transfer to the IMS before publication.

# STATISTICAL SCIENCE

Volume 3, Number 3 August 1	988
•	
In This Issue	273
Foreword	274
Changing Research Methods in Environmental Epidemiology David E. Lilienfeld	275
Changing Policy Roles of Environmental Epidemiology Devra Lee Davis	281
Litigation and Statistics Jack B. Weinstein	286
Animal Studies of Human Hazards	298
Human Studies of Human Health Hazards: Comparison of	
Epidemiology and Toxicology	306
Quantitative Risk Assessment: Low Frequency Electromagnetic	
Fields as an Example	314
Scientific Origins of Incompatibility in Risk Assessment Paul D. Anderson	320
Sources and Policy Implications of Uncertainty in	
Risk Assessment Jack Needleman	328
Insurability of Hazardous Materials Activities	339
Tests for Biologic Markers of Genotoxic	
Exposure and Effect	346
Statistical Aspects of Using Biologic Markers	351
The Use of Biological Markers in Risk Assessment	358
Biological Markers in Tort Litigation	367
Radon As an Indoor Air Pollutant Michael E. Ginevan	371
A Little Exposure to Radon	374
Science and Values in the Regulatory Process	377

Statistical Science (ISSN 0883-4237), Volume 3, Number 3, August 1988. Published in February, May, August and November by the Institute of Mathematical Statistics, 3401 Investment Boulevard #7, Hayward, California 94545. Second-class postage paid at Hayward, California and at additional mailing offices. Postmaster: Send address changes to Statistical Science, Institute of Mathematical Statistics, 3401 Investment Boulevard #7, Hayward, California 94545.

Copyright © 1988 by the Institute of Mathematical Statistics Printed in the United States of America

# IMS CORPORATE MEMBERS

THE AEROSPACE CORPORATION Los Angeles, California

AT&T BELL LABORATORIES Murray Hill, New Jersey

BELL COMMUNICATIONS RESEARCH

Morristown, New Jersey

GENERAL MOTORS CORPORATION

Research Laboratories Warren, Michigan

INTERNATIONAL BUSINESS MACHINES CORP.

Thomas J. Watson Research Center Yorktown Heights, New York

SPRINGER-VERLAG NEW YORK INCORPORATED

New York, New York

## IMS INSTITUTIONAL MEMBERS

ACADEMIA SINICA Inst. of Statistical Science Taipei, Taiwan

ARIZONA STATE UNIVERSITY Dept. of Mathematics Tempe, Arizona

AUSTRALIAN NATIONAL UNIVERSITY Canberra, ACT, Australia

BOWLING GREEN STATE UNIVERSITY Dept. of Mathematics and Statistics Bowling Green, Ohio

CALIFORNIA STATE UNIVERSITY AT FULLERTON Dept. of Mathematics Fullerton, California

CASE WESTERN RESERVE UNIVERSITY Dept. of Mathematics and Statistics Cleveland, Ohio

CENTERS FOR DISEASE CONTROL Atlanta, Georgia

CENTRE INTERNATIONAL DE RECONTRE MATH Marseille, France

CORNELL UNIVERSITY Dept. of Mathematics Ithaca, New York

FLORIDA STATE UNIVERSITY

Dept. of Statistics Tallahassee, Florida

GEORGE WASHINGTON UNIVERSITY

Dept. of Statistics Washington, DC

HARVARD UNIVERSITY Dept. of Statistics Cambridge, Massachusetts

INDIANA UNIVERSITY Dept. of Mathematics Bloomington, Indiana

INSTITUTO MEXICANO DEL PETROLEO Mexico, DF, Mexico

IOWA STATE UNIVERSITY

Dept. of Statistics and Statistical Laboratory Ames, Iowa

JOHNS HOPKINS UNIVERSITY

Dept. of Biostatistics Baltimore, Maryland

KANSAS STATE UNIVERSITY

Dept. of Statistics Manhattan, Kansas

MARA INSTITUTE OF TECHNOLOGY

Selangor, Malaysia

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Dept. of Mathematics Cambridge, Massachusetts

MIAMI UNIVERSITY LIBRARY

Oxford, Ohio

MICHIGAN STATE UNIVERSITY Dept. of Statistics and Probability

East Lansing, Michigan

NATIONAL SECURITY AGENCY Fort George G. Meade, Maryland

NEW MEXICO STATE UNIVERSITY Dept. of Mathematical Sciences

Las Cruces, New Mexico

NORTH CAROLINA STATE UNIVERSITY

Dept. of Statistics Raleigh, North Carolina

NORTHERN ILLINOIS UNIVERSITY

Dept. of Mathematical Sciences

DeKalb, Illinois

OHIO STATE UNIVERSITY

Dept. of Statistics Columbus, Ohio

OREGON STATE UNIVERSITY

Dept. of Statistics Corvallis, Oregon

PENNSYLVANIA STATE UNIVERSITY

Dept. of Statistics

University Park, Pennsylvania

PRINCETON UNIVERSITY LIBRARY

Princeton, New Jersey

PURDUE UNIVERSITY LIBRARY

West Lafayette, Indiana

QUEEN'S UNIVERSITY

Dept. of Mathematics and Statistics

Kingston, Ontario, Canada

RICE UNIVERSITY

Dept. of Mathematical Sciences

Houston, Texas

RICE UNIVERSITY LIBRARY

Houston, Texas

THE ROCKEFELLER UNIVERSITY LIBRARY

New York, New York

SIMON FRASER UNIVERSITY Dept. of Mathematics and Statistics Burnaby, British Columbia, Canada

SOUTHERN ILLINOIS UNIVERSITY Dept. of Mathematics and Statistics

Edwardsville, Illinois

SOUTHERN METHODIST UNIVERSITY

Dept. of Statistics Dallas, Texas

STANFORD UNIVERSITY

Dept. of Statistics Stanford, California

TEMPLE UNIVERSITY Dept. of Mathematics Philadelphia, Pennsylvania

TEXAS TECH UNIVERSITY Dept. of Mathematics Lubbock, Texas

UNIVERSITY OF ARIZONA Dept. of Mathematics Tucson, Arizona

UNIVERSITY OF BRITISH COLUMBIA Dept. of Statistics Vancouver, British Columbia, Canada

UNIVERSITY OF CALGARY Dept. of Mathematics and Statistics Calgary, Alberta, Canada

UNIVERSITY OF CALIFORNIA Dept. of Statistics Berkeley, California

UNIVERSITY OF CALIFORNIA Div. of Statistics Davis, California

UNIVERSITY OF FLORIDA Dept. of Statistics Gainesville, Florida

UNIVERSITY OF GEORGIA Dept. of Statistics Athens, Georgia

UNIVERSITY OF ILLINOIS Dept. of Statistics Champaign, Illinois

UNIVERSITY OF ILLINOIS AT CHICAGO Dept. of Mathematics, Statistics, and Computer Science Chicago, Illinois

UNIVERSITY OF IOWA Dept. of Statistics and Actuarial Science Iowa City, Iowa

UNIVERSITY OF MANITOBA Dept. of Statistics Winnipeg, Manitoba, Canada

UNIVERSITY OF MARYLAND Dept. of Mathematics College Park, Maryland

UNIVERSITY OF MASSACHUSETTS Dept. of Mathematics and Statistics Amherst, Massachusetts

UNIVERSITY OF MICHIGAN Dept. of Statistics Ann Arbor, Michigan

UNIVERSITY OF MINNESOTA School of Statistics Minneapolis, Minnesota

UNIVERSITY OF MISSOURI Dept. of Statistics Columbia, Missouri UNIVERSITY OF MONTREAL Dept. of Mathematics Montreal, Quebec, Canada

UNIVERSITY OF NEBRASKA Dept. of Mathematics and Statistics Lincoln, Nebraska

UNIVERSITY OF NEW MEXICO Dept. of Mathematics and Statistics Albuquerque, New Mexico

UNIVERSITY OF NORTH CAROLINA Dept. of Statistics Chapel Hill, North Carolina

UNIVERSITY OF OREGON Dept. of Mathematics Eugene, Oregon

UNIVERSITY OF OTTAWA Dept. of Mathematics Ottawa, Ontario, Canada

UNIVERSITY OF SOUTH CAROLINA Dept. of Statistics Columbia, South Carolina

UNIVERSITY OF STOCKHOLM Institute of Actuarial Mathematics and Mathematical Statistics Stockholm, Sweden

UNIVERSITY OF TEXAS AT AUSTIN Dept. of Mathematics Austin, Texas

UNIVERSITY OF TEXAS AT SAN ANTONIO Div. of Mathematics, Computer Science, and Systems Design San Antonio, Texas

UNIVERSITY OF VICTORIA Dept. of Mathematics Victoria, British Columbia, Canada

UNIVERSITY OF VIRGINIA Dept. of Mathematics Charlottesville, Virginia

UNIVERSITY OF WASHINGTON Dept. of Statistics Seattle, Washington

UNIVERSITY OF WATERLOO Dept. of Statistics and Actuarial Sciences Waterloo, Ontario, Canada

VIRGINIA COMMONWEALTH UNIVERSITY Dept. of Mathematical Sciences Richmond, Virginia

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY Dept. of Statistics Blacksburg, Virginia

WAYNE STATE UNIVERSITY Dept. of Mathematics Detroit, Michigan

YORK UNIVERSITY Dept. of Mathematics Downsview, Ontario, Canada