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M. Gail, K. Krickeberg, J. Samet, A. Tsiatis, W. Wong

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Alain F. Zuur
Elena N. Ieno
Graham M. Smith

Analysing Ecological Data

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Alain F. Zuur
Highland Statistics Ltd.
Newburgh AB41 6FN
UNITED KINGDOM
highstat@highstat.com

Elena N. Ieno
Highland Statistics Ltd.
Newburgh AB41 6FN
UNITED KINGDOM
bio@highstat.com

Graham M. Smith
School of Science and the
Environment
Bath Spa University
Bath BA2 9BN
UNITED KINGDOM
g.m.smith@bathspa.ac.uk

Series Editors

M. Gail
National Cancer Institute
Rockville, MD 20892
USA

K. Krickeberg
Le Chatelet
F-63270 Manglieu
France

J. Sarnet
Department of Epidemiology
School of Public Health
Johns Hopkins University
Baltimore, MD 21205-2103
USA

A. Tsiatis
Department of Statistics
North Carolina State
University
Raleigh, NC 27695
USA

W. Wong
Department of Statistics
Stanford University
Stanford, CA 94305-4065
USA

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To Asterix, Juultje and Poek, for paying more attention to my laptop

***To Norma and Juan Carlos, and to Antonio (d' Aieta) who showed me
that it was worthwhile crossing the great waters...***

***To Moira, for accepting all the hours shared with my computer that
I should have been sharing with her***

Preface

‘Which test should I apply?’ During the many years of working with ecologists, biologists and other environmental scientists, this is probably the question that the authors of this book hear the most often. The answer is always the same and along the lines of ‘What are your underlying questions?’, ‘What do you want to show?’. The answers to these questions provide the starting point for a detailed discussion on the ecological background and purpose of the study. This then gives the basis for deciding on the most appropriate analytical approach. Therefore, a better starting point for an ecologist is to avoid the phrase ‘test’ and think in terms of ‘analysis’. A test refers to something simple and unified that gives a clear answer in the form of a p-value: something rarely appropriate for ecological data. In practice, one has to apply a data exploration, check assumptions, validate the models, perhaps apply a series of methods, and most importantly, interpret the results in terms of the underlying ecology and the ecological questions being investigated.

Ecology is a quantitative science trying to answer difficult questions about the complex world we live in. Most ecologists are aware of these complexities, but few are fully equipped with the statistical sophistication and understanding to deal with them.

Even data gathered from apparently simple ecological research can require a level of statistical awareness rarely taught at the undergraduate or even the post-graduate level. There is little enough time to teach the essentials of ecology, let alone finding the time to teach ‘advanced’ statistics. Hopefully, for post graduates moving into academia there will be some advanced statistical support available, but many ecologists end up working in government, a voluntary organisation or consultancy where statistical support is minimal.

Although, the authors of this book believe that a quantitative approach is at the core of being a good ecologist, they also appreciate how challenging many ecologists find statistics. This book is therefore aimed at three levels of reader.

At one level it is aimed at making ecologists aware of how important it is to design scientifically robust ecological experiments or monitoring programmes, and the importance of selecting the best analytical technique. For these readers we hope the book, in particular the case studies, will encourage them to develop their personal statistical skills, or convince them they need statistical support.

On the next level it is aimed at the statistically literate ecologist, who may not be fully aware of the techniques we discuss, or when to use them. Hopefully, we have explained things well enough for these readers to feel confident enough to use some of the techniques we describe. Often these techniques are presented in a

fairly impenetrable manner, even for the statistically aware ecologist, and we have tried to make our presentation as 'ecologist friendly' as possible.

Finally, we hope the book will be of value to statisticians, whether they have a background in ecology or statistics. Ecological data can be particularly challenging to analyse, and we hope that providing an insight into our approach, together with the detailed case studies, will be of value to statistician readers, regardless of their background and expertise.

Overall, however, we hope this book will contribute in some small way to improving the collection and analysis of ecological data and improve the quality of environmental decision making.

After reading this book, you should be able to apply the following process: 'These are my questions', 'This is my statistical approach', 'Here is proof that I did it all correct (model validation)', 'This is what the data show' and 'Here is the ecological interpretation'.

Acknowledgement

A large part of the material in this book has been used by the first two authors as course material for MSc and PhD students, post-docs, scientists, both as academic and non-academic courses. We are greatly indebted to all 1200–1500 course participants who helped improve the material between 2000 and 2005 by asking questions and commenting on the material.

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Alain F. Zuur
Elena N. Ieno
Graham M. Smith

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Contributors

BASTIDA, R.
Departamento de Ciencias Marinas
Universidad Nacional de Mar del Plata
Consejo Nacional de Investigaciones Científicas y Técnicas
Casilla de Correo 43
(7600) Mar del Plata
Argentina

BASUALDO, M.
Fac. Cs. Veterinarias
UNCPBA, Campus Universitario
-7000-Tandil
Argentina

BUDGEY, R.
Central Science Laboratory
Sand Hutton
York, YO41 1LZ
United Kingdom

CABRAL, H.
Universidade de Lisboa
Faculdade de Ciências, Instituto de Oceanografia,
Campo Grande
1749-016 Lisboa
Portugal

CAMPBELL, N.
School of Biological Sciences
University of Aberdeen
Zoology Building
Tillydrone Avenue
Aberdeen, AB24 2TZ
United Kingdom
Current address:
FRS Marine Laboratory
375 Victoria Road.
Aberdeen, AB11 9DB
United Kingdom

CHIZHIKOVA, N.A.
Faculty of Ecology
Kazan State University
18, Kremlevskaja Street
Kazan, 420008
Russia

CLAUDE, J.
Université de Montpellier 2
ISE-M, UMR 5554 CNRS, cc 64
2, place Eugène Bataillon
34095 Montpellier cedex 5
France

DEVINE, J.A.
Memorial University
Department of Biology
4 Clark Place
St. John's NL, A1C 5S7
Canada
Current address:
Middle Depth Fisheries & Acoustics
National Institute of Water and Atmospheric Research Ltd
Private Bag 14-901 Kilbirnie
Wellington 6241
New Zealand

DIJKEMA, K.S.
Wageningen IMARES, Department Texel
Institute for Marine Resources & Ecosystem Studies
P.O. Box 167
1790 AD Den Burg, Texel
The Netherlands

ELPHICK, C.S.
Department of Ecology and Evolutionary Biology
University of Connecticut
75 N. Eagleville Road, U-43
Storrs, CT 06269-3043
USA

ERZINI, K.
CCMAR
Universidade do Algarve
8005-139 Faro
Portugal

GALLEGO, A.
FRS Marine Laboratory
375 Victoria Road
Aberdeen, AB11 9DB
United Kingdom

GUEVARA, S.
Instituto de Ecología, A.C.
km 2.5 Carretera antigua a Coatepec 351, Congregación El Haya
Xalapa 91070, Veracruz
Mexico

HAY, S.
FRS Marine Laboratory
375 Victoria Road
Aberdeen, AB11 9DB
United Kingdom

IENO, E.N.
Highland Statistics LTD.
6 Laverock Road
Newburgh, AB41 6FN
United Kingdom

JANSSEN, G.M.
Directorate-General of Public Works and Water Management RWS-RIKZ
P.O. Box 207
9750 AE Haren
The Netherlands

JOLLIFFE, I.T.
30 Woodvale Road
Gurnard, Cowes
Isle of Wight, PO31 8EG
United Kingdom

KRIJGSVELD, K.L.
Bureau Waardenburg
P.O. Box 365
4100 AJ Culemborg
The Netherlands

LABORDE, J.
Instituto de Ecología, A.C.
km 2.5 Carretera antigua a Coatepec 351, Congregación El Haya
Xalapa 91070, Veracruz
Mexico

LEARMONTH, J.A.
School of Biological Sciences
University of Aberdeen
Zoology Building
Tillydrone Avenue
Aberdeen, AB24 2TZ
United Kingdom

LIRA-NORIEGA, A.
Instituto de Ecología, A.C.
km 2.5 Carretera antigua a Coatepec 351, Congregación El Haya
Xalapa 91070, Veracruz
Mexico
Current address:
Instituto de Ecología, U.N.A.M.
Ciudad Universitaria, Circuito Exterior S/N. anexo a Jardín Botánico
México D.F. 04510
Apdo. Postal 70-275
Mexico

LYKKE, A.M.
Department of Systematic Botany
Universitetsparken, bygn. 1540
8000 Aarhus C
Denmark

LYUBINA, O.E.
Faculty of Ecology, Kazan State University
18, Kremlevskaja street
Kazan, 420008
Russia

MACKENZIE, K.
School of Biological Sciences
University of Aberdeen
Zoology Building
Tillydrone Avenue
Aberdeen, AB24 2TZ
United Kingdom

MARTIN, J.P.
Centro de Investigaciones de Puerto Deseado
Universidad Nacional de la Patagonia Austral
CC 238 (9050), Puerto Deseado
Argentina

MBOW, C.
Institut des Sciences de l'Environnement, Faculté des Sciences et Techniques
Université Cheikh Anta Diop
BP 5005 Dakar-Fann
Senegal

MEESTERS, H.W.G.
Wageningen IMARES, Department Texel,
Institute for Marine Resources & Ecosystem Studies
P.O. Box 167
1790 AD Den Burg, Texel
The Netherlands

MULDER, S.
RIKZ
P.O. Box 207
9750 AE Haren
The Netherlands

MUKHARAMOVA, S.S.
Faculty of Ecology
Kazan State University
18, Kremlevskaja Street
Kazan, 420008
Russia

PAN, M.
FRS Marine Laboratory
375 Victoria Road.
Aberdeen. AB11 9DB
United Kingdom

PIERCE, G.J.
School of Biological Sciences
University of Aberdeen
Zoology Building
Tillydrone Avenue
Aberdeen, AB24 2TZ
United Kingdom

REED, J.M.
Department of Biology
Tufts University
Medford, MA 02155
USA

ROGOVA, T.V.
Faculty of Ecology
Kazan State University,
18 Kremlevskaja Street
Kazan, 420008
Russia

SAMBOU, B.
Institut des Sciences de l'Environnement, Faculté des Sciences et Techniques
Université Cheikh Anta Diop
BP 5005 Dakar-Fann
Senegal

SÁNCHEZ-RÍOS, G.
Instituto de Ecología, A.C.
km 2.5 Carretera antigua a Coatepec 351, Congregación El Haya
Xalapa 91070, Veracruz
Mexico

SANTOS, M.B.
Instituto Español de Oceanografía
Centro Oceanográfico de Vigo
P.O. Box 1552
36200, Vigo
Spain

SAVELIEV, A.A.
Faculty of Ecology
Kazan State University.
18 Kremlevskaja Street
Kazan, 420008
Russia

SIKKINK, P.G.
College of Forestry and Conservation
The University of Montana
Missoula, MT 59812
USA

SMITH, G.M.
School of Science and Environment
Bath Spa University
Newton Park, Newton St Loe
Bath BA2 9BN
United Kingdom

TRASENS, M.
Departamento de Ciencias Marinas
Universidad Nacional de Mar del Plata
Consejo Nacional de Investigaciones Científicas y Técnicas
Casilla de Correo 43, (7600) Mar del Plata
Argentina

TRENDAFILOV, N.
Department of Statistics
The Open University
Walton Hall
Milton Keynes
MK7 6AA
United Kingdom

TUCK, I.
FRS Marine Laboratory
P.O. Box 101
375 Victoria Road
Aberdeen, AB11 9DB
United Kingdom
Current address:
NIWA
269 Khyber Pass Road
Newmarket, Auckland 1023
New Zealand

VAN DUIN, W.E.
Wageningen IMARES, Department Texel
Institute for Marine Resources & Ecosystem Studies
P.O. Box 167
1790 AD Den Burg, Texel
The Netherlands

ZUUR, A.F.
Highland Statistics LTD.
6 Laverock Road
Newburgh, AB41 6FN
United Kingdom