

## TEACHING STATISTICS TO ENVIRONMENTAL SCIENTISTS

Jennifer Brown

University of Canterbury, New Zealand

David Borchers

University of St. Andrews, Scotland

jennifer.brown@canterbury.ac.nz

*Teaching statistics to scientists and managers who work in environmental science can be stimulating and rewarding. Environmental science is data-orientated and there is a growing need for better statistical understanding amongst environmental scientist and managers. The Biomathematics Research Centre at University of Canterbury and the Centre for Research Unit for Wildlife Population Assessment (RUWPA) at St. Andrews offer a workshop covering some aspects of environmental statistics. We discuss some of our experiences from these.*

### INTRODUCTION

Teaching statistics to people working in environmental science has its challenges. The first of these is that many environmental scientists and managers have a fear of statistics and would rather be out in the field collecting data than sitting in a classroom learning about how to deal with the data!

The Biomathematics Research Centre (BRC) at University of Canterbury and the Centre for Research Unit for Wildlife Population Assessment (RUWPA) at St. Andrews both offer a number of statistics workshops to environmental scientists and managers. These courses are targeted at specific user groups. In New Zealand, Dr. Brown has had a long association with the government agency responsible for conservation management (Department of Conservation, DOC) and has developed courses for DOC staff on a range of topics from environmental monitoring, introductory data analysis, to advanced data analysis, generalised linear models and the use of software (*SPSS*, *S Plus*). She has presented workshops on environmental statistics at conferences and runs a statistics training session associated with accrediting NZ wildlife managers. Dr. Borchers has some 15 years experience running workshops on distance sampling and animal abundance estimation methods. We discuss some ideas on successful workshops formats.

### ENVIRONMENTAL WORKSHOPS

Participants who attend this kind of workshop usually have field-experience. The success of workshops can often be measured by how well the presenters integrate the participants' knowledge into the programme. Firstly the example datasets have to be realistic and relevant. This can be achieved in part by encouraging participants to bring their own problems and datasets to the workshop.

The second key to success is to realise that people working in environmental science often have limited mathematical background, they are uncomfortable dealing with statistics and algebra, and cope with this in different ways. We have found that the statistics needs to be presented more by example and less by use of algebra and mathematical notation. Algebra and mathematical equations can be provided as appendices and interested participants can review them later. There are many clever ways to get statistical concepts across without using algebra. In the NZ workshops Dr. Brown has even had field biologists standing up in front of the class acting as a confidence-interval! It takes a little imagination and a lot of humour to do this, but at the end the participants understand what confidence interval really is. Once the laughter dies down she presents them with the statistical formulae and by then they are ready to understand the mathematics.

A formula for workshops that we have found successful is to use a problem-based learning environment. To present the initial concepts of mark recapture statistics, Dr. Borchers uses an exercise involving straws which are removed, marked, replaced and so on. Participants usually get very involved in the exercise with minimal instruction and need little direction from the instructor. Once the concept has been understood through the hands-on exercise the

mathematical framework can be presented. Analyses of pre-prepared example datasets and/or datasets the participants bring themselves serves to reinforce and generalize learning from hands-on exercises.

Participants are always keen to bring to workshops their own data and describe their field study. Over the years we have found that there are advantages and disadvantages in having open sessions. The advantages are that the data are real and the studies are always interesting. The disadvantage is that it takes considerable time to describe the study and research aims, access the data and develop a statistical discussion on the presentation. A more successful approach is to allow participants to pre-submit case study material including a brief introduction (e.g., in power point), and the data. Then, prior to the workshop, the data can be massaged into a more generic form, and data analysis options tested.

The workshops run by the groups in NZ and Scotland are different in content, delivery style and target audience, yet there are many statistical concepts taught that are in common. These are concepts associated with estimation and the ideas of collecting data from only a sample of the population, uncertainty in estimation, randomisation, probability, bias and variance, confidence intervals, and model selection.

## CONCLUSION

Participants at these workshops are highly motivated and genuinely want to learn more statistics. They are working as ecologists, biologists and environmental scientists and managers and have real environmental questions they are trying to understand. This background is an advantage because their experience helps them to focus on key aspects of the problems they face. Different teaching styles are needed to engage professional participants compared with tertiary education students. The biological and environmental background and field experience of the participants means that problem-based learning techniques are very successful. Complex statistical concepts can be presented by first taking a hands-on approach. Once the concept is understood, the participants are often more receptive to the understanding the theory.

Teaching statistics to people working in environmental science is very rewarding. The participants are motivated, hard working and enthusiastic to learn. As an added bonus, if it helps environmental managers do a better job, maybe statistics workshops help the environment too.

## ACKNOWLEDGEMENTS

Thanks to Bryan Manly and Ian Westbrooke for the opportunity to work with them on statistics workshops.