Obtaining Information for Decision Making: A Practical Approach to Sampling

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Overview of the Course

The course is aimed at providing ground rules for obtaining data that can be used to aid decision making. The course includes fundamental methods used in sampling and monitoring with emphasis on practical applications.

The course includes an examination of the type of data that are required by decision makers, with particular emphasis on environmental issues. This will lead on to decision rules, consequences of incorrect decisions and what parameters should be estimated, and the definition of the population to be sampled.

Examples will be given that illustrate the relationship between precision, accuracy and bias.

An overview of sampling schemes will be given. This will cover simple random sampling, stratified random sampling, systematic sampling, cluster sampling, and other more complex schemes that are model orientated. Problems and benefits of composite sampling will be included.

Design of monitoring schemes will be discussed with emphasis on the frequencies of measurements that are required to detect trends and changes in environmental time series.

The course will be illustrated with practical examples from the presenters' experience. There will be group discussions of sampling problems. Attendees will be encouraged to bring problems to the course.

Aim of Course:

To introduce the concepts of sampling and monitoring
Provide a bridge between sampling theory and practice
Enable sources if bias to be identified
To enable decision makers to obtain critical information in a cost-effective manner

By the end of this course you should be able to:

Understand the steps involved in sampling
Scope a sampling scheme
Understand the terminology used in a sampling and monitoring
Understand basic design principles of sampling and monitoring

1. Introduction

Before you start – what is the purpose of your sampling? Always keep that question in mind.

2. Defining the problem

We start by considering the definition of sampling.

A definition of sampling is 'A **set** of **elements** drawn from and **analyzed** to **estimate** the **characteristics** of a **population**'. View the slides to for a discussion of this definition, and in particular the interpretation of the words highlighted in bold.

At times it is necessary to redefine the problem to give useful answers.

3. Decision Rules

What information do you need to make the decision? This requires confidence intervals that are discussed in Section 8.

4. Precision and Accuracy

What is the difference? What is bias?

5. Simple random sampling

In this module you will be introduced to sampling schemes. The concepts illustrated with simple random sampling (SRS) and you will be asked to do work through a simple exercise. After this module you will be able to design and analyse a simple sampling scheme

6. Stratified and Cluster Sampling

In this session we consider two sampling schemes- stratified random sampling and cluster sampling. We learn how and when to use these schemes and how to estimate the population mean and its standard error for each system. The session includes exercises on each sampling type.

7. Other sampling schemes

More useful sampling schemes sampling schemes are considered including systematic sampling, composite sampling and regression sampling.

8. Data acquisition

A look at some the instruments used to take samples

e.g. cores v spades

9. How many samples

Perhaps the most commonly asked question and the one answered with theory that generally is not practical

10. Monitoring

A few pointers on designing monitoring systems

11. Estimating confidence intervals

In this session we introduce the concept of confidence intervals. We start with a simple case and how they can be estimated using a 't' distribution. We then consider the more realistic situation where a normal distribution cannot be assumed.
Two other cases that are considered consider the binomial and the Poisson distributions.

12. Ways to increase precision

There are a variety of ways you can increase accuracy – here are some of them.

13. Other resources

Useful references

Cochran WG (1977) Sampling techniques 3rd Edition Wiley International, NY
de Gruijter J, Brus D, Bierkens M and Knotters M (2006) Sampling for natural resource monitoring Springer, Berlin
Maher C and Burke T (1991) Informed decision making Longman-Cheshire, Melbourne
Moser CA and Kalton G (1973) Survey methods in social investigation Heinemann Education Books, London

Useful standards

CODEX STAN 193-1995) Codex General Standard for Contaminants and Toxins in Food and Feed
CAC/GL 50 2004 General Guidelines on Sampling
CAC/GL 33-1999Recooended Methods of Sampling for the Determination of Pesticide Residues for Compliance with MRLs

Other Websites

http://www.sampler-education.dhi.dk/

Exact Binomial and Poisson Confidence Intervals available at http://statpages.org/confint.html

ProUCL (2009). Statistical Software ProUCL 4.0 for Environmental Applications For Data Sets with and without Nondetect Observations Statistical Software ProUCL 4.0 for Environmental Applications For Data Sets with and without Nondetect Observations. US Environmental Protection Agency http://www.epa.gov/esd/tsc/software.htm