Making decisions about experimental designs

Types of Design

There are a large number of classes of experimental design. They differ with respect to the relationship between the experimental treatment(s) and the measured response. The following summary table is based on Table 7.1 in Brown and Rothery (1993).

Population characteristics	Experimental aims	Sampling design	Experimental design
Homogeneous random variation	Estimating and comparing population parameters	Simple random sampling	Completely randomized design.
Heterogeneous with systematic and random variation	Estimating and comparing means	Stratified random sampling	Randomised block design
Trends	Analysis of pattern and process	Systematic sampling	Response surface Repeated measures
Factorial structure	Estimating and comparing means for combinations of factors	Factorial designs	Factorial designs
Dependence relationship	Prediction of a value from a single predictor	Simple random sampling	Regression analysis
	Prediction of a value from more than one predictor		Multiple regression

A comprehensive overview of different designs is provided in the USEPA Guidance for choosing a sampling program. The document includes discussion on the following types of Sampling Designs:

- Judgmental Sampling
- Simple Random Sampling
- Stratified Sampling
- Systematic and Grid Sampling
- Ranked Set Sampling

- Adaptive Cluster Sampling
- Composite Sampling

Relating design to analysis

An important question is the appropriate statistical tests for each design. The individual tests are discussed and/or referenced more fully in the section on statistics. and the emphasis here will be a categorisation of design and tests as the requirements for the tests need to be incorporated into the design at the beginning and not fudged at the end. Similarly, once the best statistical method has been chosen and has provided the test of the hypothesis, accepting the result is preferable to rejecting it and searching for a "better" method.

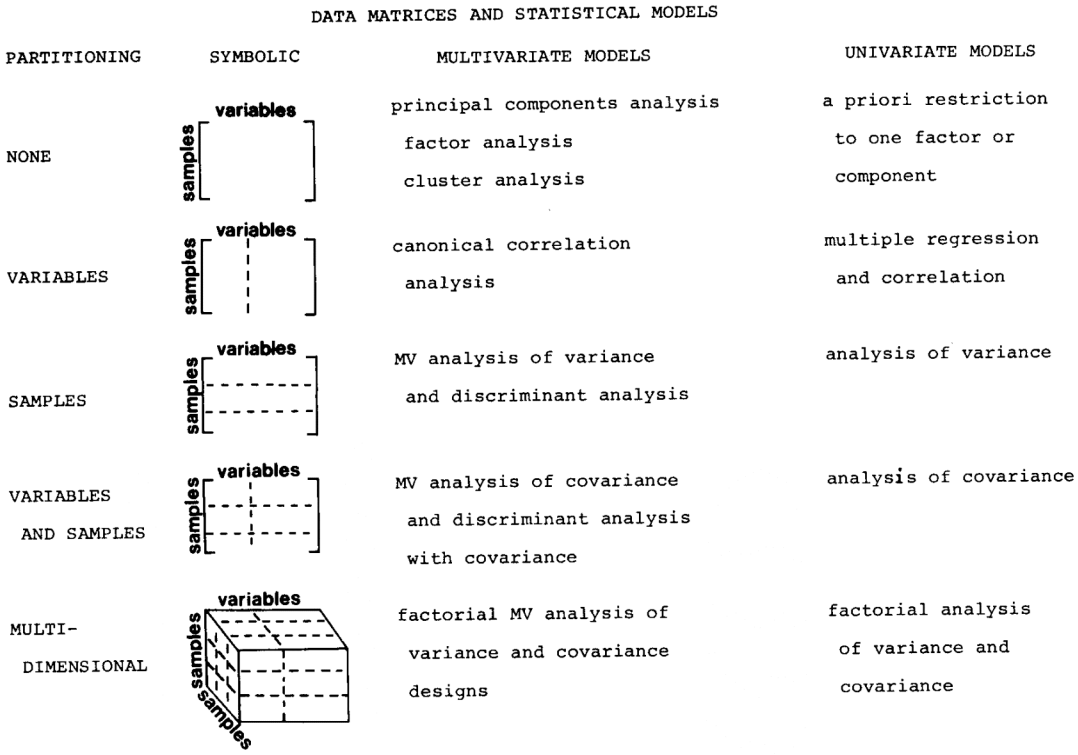
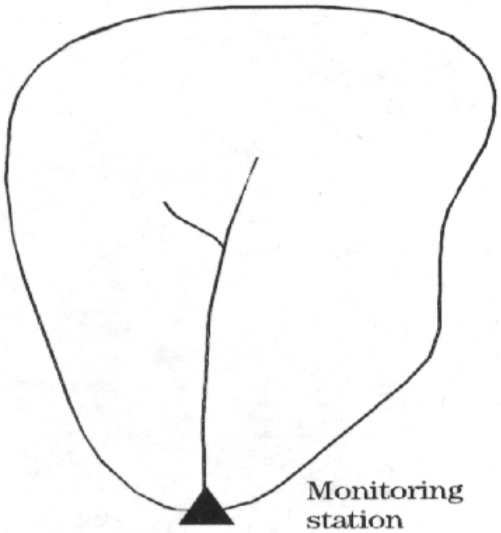


FIGURE 3.3 Data matrices and statistical models

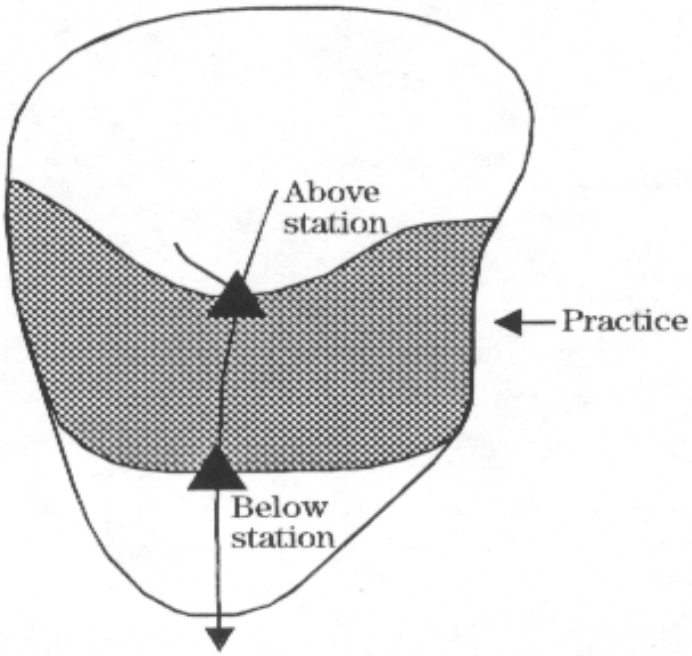
Less than ideal designs

Common situations that apply to water quality sampling programs are discussed in more detail in Chapter 4 of the USDA National Handbook on Water Quality Monitoring, from the following examples are taken.

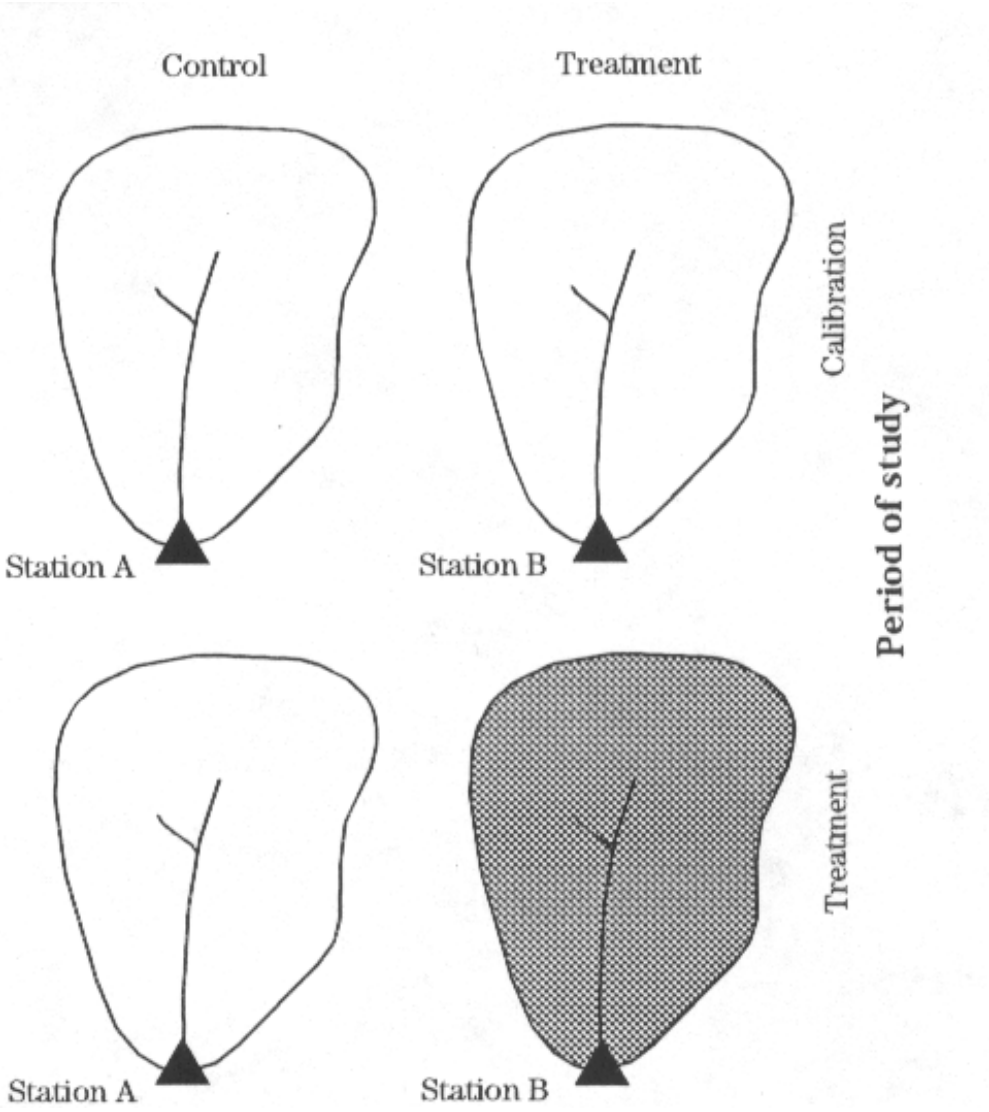
Single watershed - single site



Single watershed - "above and below" sites



Paired watersheds



Flexible and Comprehensive Monitoring

A good monitoring program will be comprehensive to the extent that it is well thought out with clear objectives, satisfies the principles for a good design, and is methodologically sound. It will also be flexible in that there is a clearly articulated process for analysis of the data and feedback to managers and other stakeholders. The program should be adaptable in response to data because the outcome is improved knowledge and management, not just data.