



Module 2: Environmental Sampling

2.1 Introduction Populations and Samples



Introduction

- ◆ According to American Heritage Dictionary of the English Language, statistics is

“The mathematics of the collection, organization, and interpretation of numerical data, especially the analysis of population characteristics by inference from sampling.”



Introduction

- ♦ Almost everything we understand about the way the world works is based on some sort of data. And that data, by its nature is incomplete and imperfect. Incompleteness comes from our inability to study every single element of a situation under study. Imperfection includes things such as errors in measurement. Therefore, we must make inferences about the whole by only seeing a fuzzy picture of a part of the whole.
- ♦ All data must be analyzed and interpreted. Statistics is the science of doing this well.

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Introduction

- ♦ Quote: “*He uses statistics as a drunken man uses lamp-posts – for support rather than illumination*”
Andrew Lang (1844-1912), Scottish author. Quoted in:
Alan L. Mackay, *The Harvest of a Quiet Eye* (1977)
- ♦ Fact: All statistical methods rely on some set of assumptions, some more difficult to meet than others. Often those who try to prove a preconceived point using statistics don't understand the foundation of the techniques, when they apply, and how to appropriately interpret the results. Or, worse, they knowingly misapply techniques to achieve a particular result.

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Introduction

- ◆ Quote: “*You can prove anything with statistics*”

Anonymous

- ◆ Fact: Data don't lie. However, it isn't always easy to determine how best to analyze and interpret data.
- ◆ Well intentioned and careful data analysts, working with the same data but with different sets of assumptions, may obtain different results.

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Introduction

- ◆ Key questions to ask before analyzing a data set are:
 - What is the research question that are you trying to answer?
 - What data is needed to answer that question?
 - What assumptions are reasonable to make concerning that data?

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Introduction

- ◆ Quote: "*There are three kinds of lies: lies, damned lies, and statistics*"

Benjamin Disraeli

- ◆ Most of the time, if you can answer the above questions and apply appropriate techniques based on the answers, then you will get a "correct" result and the use of other (also appropriate) statistical techniques will give the same result.

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Introduction

- ◆ Analyzing data and drawing defensible inferences is more than mathematics. It is both an art and a science and requires more than merely learning a set of tools, it requires careful thought and analysis.

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Populations and Samples

- ♦ The population is the entity that you want to understand. It could be a group of people, a group of animals living in a contaminated area of land, a body of water, the top 6 inches of soil in a particular area, or a body of air.
- ♦ The population is a collection of N items of interest (where N could be infinite).

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Populations and Samples

- ♦ The sample units are all those items in the population that might be sampled.
- ♦ Sample units are the individual items in the population.
- ♦ If the population is land, air, or water, the sample units must be defined by size and by characteristics of space and time.

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Populations and Samples

- ◆ The sample are the n items that you actually collect and measure.
- ◆ If $n=N$ then a complete census of the population was done. This is almost never the case in practice.

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Populations and Samples

- ◆ We use the sample to draw conclusions about the population. Since $n < N$ and our measurement techniques are imperfect, we have imperfect information about the population.
- ◆ How the sample is drawn from the population is crucial to how well we can make inferences about the population. This is the basis for studying sampling design.

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