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Sound ethical decisions based on data! SM

Advanced Statistical Design and Analysis

with STATGRAPHICS

for the

Environmental Industry

Foundation for Sound Decisions with Integrity

(Second course of two-course sequence: Foundation & Advanced)

Course Code: *Adv-Env* Course, 5 Days, 4.0 CEUs [for 1st course see *Fnd-Env* outline]
Prerequisites:

1. ***Experience*** working with data
2. ***Alpine Analytics Foundation Course*** (The *Advanced Course* is designed to build on the structure, framework, knowledge and skills developed in the *Foundation Course*)
3. *College course(s)* in statistics helpful, but not required

Reference Texts and Guidelines:
Primary Materials: (included with course)
Helsel, Dennis R. and Robert M. Hirsch. 1992. *Statistical Methods in Water Resources.* (Excellent, highly respected text for dealing with peculiarities of any environmental data.)
Gilbert, Richard O. 1987. *Statistical Methods for Environmental Pollution Monitoring.* (Classic)
Other texts and EPA reference material will be used depending on client needs and their specific focus. Examples and exercises come from broad areas of environmental data.
Additional References[1]: (available upon request through special order)
Cressie, Noel. 1993. *Statistics for Spatial Data.*
Ginevan, M.E. & D.E. Splitstone. 2004. *Statistical Tools for Environmental Quality Measurement.*
Helsel, Dennis R. 2005. *Nondetects and Data Analysis: Statistics for Censored Environmental Data*
Patil, G.P and C.R. Rao (Eds). 1994. *Environmental Statistics.*
Patil, G.P. and C.R. Rao (Eds). 1993. *Multivariate Environmental Statistics.*
Thompson, Steven K. 2002. *Sampling.*
Manual and Course Materials: Copy of all PowerPoint presentation slides and data sets
STATGRAPHICS: Get training and experience using the software; buy from **Alpine Analytics**

Who this course is for: Environmental scientists, engineers, technicians and other technical professionals who must acquire, analyze, understand, interpret, and summarize environmental data and then communicate results; also environmental and natural resource managers who must make sound environmental decisions with integrity based on environmental data.
Professional areas would include: Geologists and geochemists, geo-hydrologists, water quality and watershed specialists, environmental chemists and toxicologists, soil scientists, field botanists and plant ecologists, air quality specialists, animal ecologists, general and community ecologists.
The ***Advanced Course*** is for environmental professionals who must be proficient in the tools and techniques required for well designed environmental assessment studies.

[1] Course structure and content draws on these materials for concepts and examples.

I. Framework for Statistical Thinking

- ***A. Review of Concepts***
- ***B. Refreshing Your Statgraphics Skills:*** Foundation Course *statistical material reviewed through coordinated set of exercises on Statgraphics*

II. Environmental Measurements

- ***A. Laboratory Measurements***
  1. **Measurement Concepts:** Measurement errors and uncertainty
  2. **Measurement Variability:** Repeatability and reproducibility; inter-laboratory variability
  3. **Assay Calibration**
  4. **Reported Values:** Range and accuracy; reporting limits (measurement sensitivity, LOD/LOQ, Nondetects)
- ***B. Field Measurements***
  1. **Types of Environmental Field Measurements**
  2. **Sampling Units, Plot Shapes and other practical collection issues**

III. Robust Statistics for Environmental Data

- ***A. Robust Statistics Concepts:*** *Exploratory data analysis; robust summary statistics and nonparametrics; resampling techniques (Bootstrap & Jackknife); non-normality and outlier detection; working with quantiles*
- ***B. Comparing Two Groups***
- ***C. Comparing Three or More Groups***
- ***D. Correlation***
- ***E. Regression, Trends and Seasonality***

IV. Nondetects and Data Analysis — *Handling Left-Censored Environmental Data*

- ***A. Statistical Understanding of the Reporting Limit Problem***
- ***B. Three Approaches: Substitution, MLE, Nonparametrics***
- ***C. Plotting Data with Nondetects***
- ***D. Computing Summary Statistics***
- ***E. Computing Interval Estimates***
- ***F. Robust Statistical Analysis for Comparisons and Relationships***
- ***G. All Data Below Reporting Limit* — What now?**

V. Environmental Assessment: *Sampling Design and Analysis*

- ***A. Goals and Objectives for Environmental Sampling Design***
- ***B. Basic Sampling:* Concepts and Simple Designs**
  1. **Equal Probability Sampling: Simple Random Sampling**
     - a) **Estimation of Population Values and Site-Wide Measures:** Mean, Site Total, Proportions, Quantiles, and Ratios
     - b) **Sample Size and Precision of Estimates**
  2. **Unequal Probability Sampling**
- ***C. Estimating Site-Wide Population Values:* Classical Sampling Designs**
  1. **Stratified Sampling**
  2. **Cluster Sampling**
  3. **Systematic Sampling**

4. **Composite Sampling**
5. **Multistage Sampling**
6. **Double Sampling**
7. **Others:** Network Sampling, Ranked Set Sampling

D. Detectability Sampling: Elusive Populations, Location of Hot Spots, Common Source vs Point Source Contamination and Pollution

1. **Basics of Detectability: Concepts, Measures and Simple Sampling**
2. **Grid Sampling**
3. **Line Transects and Variable Circular Plots**
4. **Line Intercept Sampling**
5. **Capture-Recapture Sampling** (special topic for clients with interest in animal presence/abundance estimation)

E. Adaptive Sampling

1. **Basic Concepts**
2. **Adaptive Cluster Sampling**
3. **Systematic and Strip Adaptive Cluster Sampling**
4. **Stratified Cluster Sampling**

F. Spatial Sampling

1. **Spatial Design and Spatial Prediction**
2. **Statistics for Spatial Data: General Concepts**
   a) **Geostatistics**
   b) **Lattice Data**
   c) **Point Patterns**

VI. Environmental Monitoring: *Sampling Design and Analysis*

A. Variability Over Time
B. Detection of Change
C. Control Charts and Tolerance Charts
D. Detecting and Estimating Trends
E. Modeling and Prediction of Temporal Data: *Trends, Seasonality, Cycles (Regression Modeling and ARIMA Methods)*

VII. Ecological Statistics

A. Ecological Concepts and Measures: *Species diversity; species abundance relationships; species affinity relationships; and others*
B. Environmental and Ecological Indices
C. Multivariate Analysis of Ecological Data: *Ordination and Classification*

VIII. Special Topics in Environmental Application Fields

A. Contamination and Pollution Monitoring
B. Polluted Site Cleanup
C. Water Resources: Quality and Quantity
D. Air Quality
E. Soil Quality, Fertility and Agriculture
F. Land Reclamation and Success Standards
G. Common Waste Management
H. Nuclear Waste Storage and Site Management
I. Environmental Toxicology and Risk Assessment