Quantitative Ecotoxicology

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General

DAY	TOPIC
1	Introduction; Basic Concepts of Ecotoxicology as a Science
	Bioaccumulation: General; Reaction Order; Elimination
	Bioaccumulation: Bioaccumulation
	Bioaccumulation: Bioaccumulation Models; Bioavailability
	First Quiz
2	Lethal Effects: Measures of Lethality
	Lethal Effects: Dose-Response Models
	Lethal Effects: Failure Time Models & Factors Modifying Lethality
	Second Quiz
3	Chronic and Sublethal Effects: ANOVA; Post-ANOVA Tests
	Chronic and Sublethal Effects
	Chronic & Sublethal Effects: Post-ANOVA; ICp; Bioequivalence; Biol. Sign.
	Third Quiz
4	Effects on Populations: Population Size; Growth; Stability
	Effects on Populations: Demography; Spatial Distribution; metapopulations
	Effects on Population Genetics
	Fourth Quiz
5	Community Effects: Simple Species Interactions
	Community Effects: Community Structure
	Community Effects: Community Function; Trophic Transfer
	Course Summary
	Fifth Quiz

Grade - Course grade will be based on five take-home exams (16 points each for a total of 80%) and class participation (20%). The exams will involve applications of concepts covered in class and statistical software used in in-class exercises. There are fifty computer-based exercises described in the exercise hand-outs.
Class – The class structure will consist primarily of lecture/discussion and then computer-based exercises from the book and hand-outs.
Textbook – Newman, M.C. 1995. Quantitative Methods in Aquatic Ecotoxicology. CRC/Lewis Publishers, Boca Raton, FL. The lectures and computational examples are structured to cover the materials in Chapters 3 through 7 although additional materials have been added to the lectures. Relevant computer code and statistical tables are provided in the appendix of this textbook.

OUTLINE FOR DAY ONE: BIOACCUMULATION

MORNING LECTURE

I. Overview

II. General Approach

- A. Elimination
  1. General
  2. Reaction Order
  3. Linear Elimination Model
  4. Monoexponential Elimination Model
  5. Elimination with Two Loss Terms from One Compartment
  6. Elimination with Two Loss Terms from Two Compartments
  7. Power Elimination Curve
  8. Michaelis-Menten (Saturation) Elimination Model
  9. Dissecting Two Compartment Models

BREAK

- B. Adsorption
  1. General
  2. Freundlich and Langmuir Equations
  3. Other Adsorption Models
- C. Accumulation Models: One Compartment
  1. Rate Constant-Based Models
  2. Clearance Volume-Based Models (Dr. Irv Schultz)

LUNCH

AFTERNOON LECTURE

- D. Accumulation Models: Several Compartments or Sources
  1. One Compartment with Uptake from Food and Water
  2. Multiple Sources and Elimination Components
  3. Complex Multiple Compartment Models
- E. Physiologically-Based Pharmacokinetic Models
  1. General
  2. Uptake from Water
  3. Uptake from Food
  4. Growth
  5. Allometry

BREAK

- F. Fugacity-Based Models

III. Modeling Bioaccumulation: Alternative Approaches

- A. Statistical Moments Approach
- B. Stochastic Models

IV. Intrinsic Factors

- A. Lipid Content
- B. Size

COMPUTER HANDS-ON EXERCISES

OUTLINE FOR DAY TWO:
LETHAL AND OTHER QUANTAL RESPONSES TO STRESS

MORNING LECTURE

I. Overview
II. Dose-Response at a Set (Time) Endpoint
- A. General
- B. Metameters of Dose and Response
- C. The LC50
    1. Litchfield-Wilcoxon Method
    2. Maximum Likelihood Method (Normal, Logistic, Weibull Models)
    3. Trimmed Spearman-Karber Method
    4. Binomial Method
    5. Moving Average Method
    6. Coping with Control Mortality
    7. Duplicate Treatments
    8. Summary of LC50 Methods
    9. Incipient LC50
    10. The Significance of the LC50

III. Time-to-Death
- A. Standard Approach
    1. General
    2. Litchfield Method for estimating LT50
    3. Lethal Threshold Concentration

BREAK
- B. The Survival Time Approach
    1. General
    2. Nonparametric Methods
    3. Parametric and Semiparametric Methods
        - a. General
        - b. Proportional Hazard Models
            - i. Assuming a Specific Model
            - ii. Cox Proportional Hazard Model
        - c. Accelerated Failure (Time) Models
        - d. General Form for Survival Time Models
        - e. Selecting the Appropriate Model

LUNCH

AFTERNOON LECTURE

IV. Quantifying Effects of Intrinsic Factors
- A. Overview
- B. Inorganic Toxicants
    1. Ammonia
    2. Metals
        - a. Water
        - b. Sediments

BREAK
- C. Organic Toxicants

V. Quantifying Effects of Intrinsic Factors
- A. Overview
- B. Acclimation
- C. Size

VI. Toxicant Mixtures
VII. Summary

COMPUTER HANDS-ON EXERCISES

OUTLINE FOR DAY THREE: HYPOTHESIS TESTS FOR DETECTION OF CHRONIC LETHAL AND SUBLETHAL STRESS

MORNING LECTURE

I. General
II. Method Selection
III. One-Way Analysis of Variance
IV. Test of Normality: Shapiro-Wilk's Test
V. Test of Homogeneity of Variances: Bartlett's Test
VI. Treatment Means Compared with the Control Mean
- A. Dunnett's Test
  - 1. Equal Number of Observations
  - 2. Unequal Number of Observations
  - 3. Unequal Variances
- B. t-Test with Bonferroni's Adjustment
- C. Dunn-Šidák t-Test

BREAK

VII. Monotonic Trend: Williams's Test
VIII. Steel's Multiple Treatment-Control Rank Sum Test
IX. Wilcoxon Rank Sum Test with Bonferroni's Adjustment

LUNCH

AFTERNOON LECTURE

X. Inferring Biological Significance from Statistical Significance
- A. EC_x/IC_p Approach

XI. Summary of Hypothesis Testing Approach

BREAK

XII. Bioequivalence Testing Approach (Philip Dixon)
XIII. NOEL/LOEL VERSUS EC_x Approaches
- A. Statistical Comparison
- B. Examples of Models

COMPUTER HANDS-ON EXERCISES

OUTLINE FOR DAY FOUR.
EFFECTS AT THE POPULATION LEVEL

MORNING LECTURE

I. General
- A. Population Levels Research
- B. What is A Population?

II. Population Size
- A. General
- B. Measurement of Population Size
  - 1. General
  - 2. Quadrat Estimates
  - 3. Mark-Recapture Estimates
  - 4. Removal-Based Estimates
- C. Simple Population Growth
  - 1. The Exponential Growth Model
  - 2. The Logistic Growth Model
  - 3. Population Stability

BREAK

III. Demography
- A. General
- B. Life Tables
  - 1. General
  - 2. Death
  - 3. Birth and Death
  - 4. Other Considerations
- C. Matrix-based Formulations

IV. Spatial Distribution of Individuals
- A. General
- B. Indices for Discrete Sampling Units
- C. Indices for Arbitrary Sampling Units
  - 1. Indices Based on Quadrats
  - 2. Indices Based on Distance
- D. Metapopulations - Source and Sink Consequences

Lunch

AFTERNOON LECTURE

V. Population Genetics
- A. Basic Concepts
  - 1. Natural Selection
  - 2. Hardy-Weinberg Equilibrium
  - 3. Genetic Drift
    - a. General
    - b. Effective Population Size
  - 4. Wahlund Effect

5. Quantitative Genetics

BREAK

B. Lethal Stress (Viability)
C. Selection Components
D. Tolerance

COMPUTER HANDS-ON EXERCISES

OUTLINE FOR DAY FIVE:
EFFECTS AT THE COMMUNITY LEVEL

MORNING LECTURE

I. General

II. Simple Species Interactions
- A. Predator-Prey Interaction
- B. Interspecies Competition
  - 1. Two Species
  - 2. Several Species
- C. Symbiosis

III. Community Structure and Function
- A. General

BREAK
- B. Community Structure
  - 1. General
  - 2. Species Abundance
    - a. General
    - b. Geometric Series Model
    - c. Log Normal Model
    - d. Log Series Model
    - e. Broken Stick Model
    - f. Pollution Effect on Abundance Curves
  - 3. Species Richness
  - 4. Species Heterogeneity ("Species Diversity")
  - 5. Species Evenness
  - 6. Community Similarity

LUNCH

AFTERNOON LECTURE
- C. Community Function
  - 1. General
  - 2. Productivity and respiration
  - 3. Detritus Processing
  - 4. Nutrient Spiraling
  - 5. Colonization and Succession

BREAK

IV. Composite Indices

V. Trophic Exchange

VI. Summary

COMPUTER HANDS-ON EXERCISES (3:30 to 5:00 PM)