NRES 798
Statistical Methods for Ecologists

Ché Elkin

Room 8-332

960-5004

Che.Elkin@unbc.ca

Course objective

- Tools for graduate work
  - Project, assisted self-learning
- Tools for ecological understanding and evaluation
- Tools for future statistical analysis

Lecture outline

Lecture	Topic
1	Ecological questions and statistical approaches
2	Probability, probability distributions, and frameworks for statistical analysis 1
3	Probability, probability distributions, and frameworks for statistical analysis 2
4	Exploring data properties (Outliers, transformations)
5	Experimental and sampling design 1
6	Experimental and sampling design 2
7	Linear models 1
8	Linear models 2
9	Linear models 3
10	Linear models 4
11	Generalized linear models 1
12	Generalized linear models 2
13	Analyzing time series 1
14	Analyzing time series 2
15	Spatial statistics 1
16	Spatial statistics 2
17	Generalized Additive models 1
18	Generalized Additive models 2
19	Model selection 1
20	Model selection 2
21	Bayesian analysis 1
22	Bayesian analysis 2
23	Data mining
24	Multivariate analysis

Labs

- Hands-on application of statistical methods
- R environment
  - Free
  - Powerful, flexible
  - Very common platform for ecologists
- Work through real data examples

Grading

- Project first report
  - Feb. 13th, 30%
- Project final report
  - April. 17th, 45%
- Lab exam
  - Lecture and lab component
  - 25%

Project aim

Design and perform the statistical analysis of a real world data set

- Assess the strengths and limitations of the data
- Compare and contrast the applicability of various statistical approaches
- Perform a “complex” statistical analysis (using R)
- Interpret and critically evaluate the strengths and weaknesses of the analysis

First report

- Hypothesis/model to be tested (15%)
  - Scientific rational for analysis
  - Framing the scientific question in statistically appropriate way
- Description of data (5%)
  - Experimental design, dependent & independent variables
  - Descriptive statistics, distributions, outliers
- Limitations of data (10%)
  - Problems
    - Experimental design limitation, sampling restraints, measurement error
- Sources of uncertainty/variability (10%)
  - What types of uncertainty can be examined, and what is unknown
- Historical approaches used for analysis (20%)
- Alternative statistical approaches (40%)
  - Comparative: strengths, weaknesses and differences of alternative approaches
  - Limitation (inappropriate because …)

Final report

- Scientific paper with **heavy** emphasis placed on statistical analysis
  - Statistics methods paper
    - Intro
      - Scientific question, emphasis on statistical framing of hypothesis being tested
      - Description of statistical "problem"
      - Description of why stats matter
      - Description of statistical approache**s**
    - Methods
    - Results
    - Discussion
      - Detailed interpretation of statistical results
      - Evaluation of shortcomings of analysis
      - Discussion of results in the context of
    - Literature cited
    - Appendix: R code for analysis

Final report

Examples: ecological statistics methods paper

- Environmental and Ecological Statistics
  - Editors-in-Chief: P. Dutilleul; B.F.J. Manly
  - http://www.springer.com/life+sciences/ecology/journal/10651

- Ecological applications
- Journal of Ecology….

Ecological Applications, 19(3), 2009, pp. 631–642

Modeling abundance using *N*-mixture models: the importance of considering ecological mechanisms

LIANA N. JOSEPH,[1,3] CHÉ ELKIN,[1] TARA G. MARTIN,[2] AND HUGH P. POSSINGHAM[1]

- Scientific question
  - How to accurately estimate species abundance from survey data
- Description of statistical "problem"
  - Statistical models of abundance often don't include detection error
    - Need to separate true variation from false variation (sampling error)
      - Not present Not observed; Present Not observed
      - Not present Observed, Present Observed
  - Large number of "zero" observations can skew abundance data
- Description of why stats matter
  - Not accounting for detection error and zero inflation can lead to spurious abundance estimates, and consequently incorrect conservation actions
- Description of statistical approaches
  - N-mixture model
    - Poisson, zero-inflated Poisson
    - Negative binomial, zero-inflated negative binomial

Report data

- Own data
- Lab group data
- Department data
- Published data
  - Old, well known.
  - Ecological applications, Ecological Monographs, Oikos
    - Data archiving

Ecological data

Data sources

- Ecological Data Wiki
  - http://ecologicaldata.org/
- Ecological Society of America Data Registry
  - http://data.esa.org/esa/style/skins/esa/index.jsp
- DRYAD
  - http://www.datadryad.org/
- LTER: Long Term Ecological Research network
  - http://metacat.lternet.edu/das/lter/index.jsp

Data lists

- NCEAS: Ecological and spatial data sources
  - https://www.nceas.ucsb.edu/scicomp/data
- UC Berkeley: Data repositories
  - http://www.lib.berkeley.edu/BIOS/data_environment.html
- Duke University: Data repositories
  - http://guides.library.duke.edu/content.php?pid=177435&sid=1709958

Be specific

Be respectful

Metadata is essential

The US Long Term Ecological Research Network

A founding member of the International Long Term Ecological Research Network

Login

Search

Browse

Browse the LTER Data Portal

Alternative: Multi-level Browse

Browse by category using the links below. The number of matching data sets (when non-LTER data are included) is shown in parentheses. *Please note: Only public documents are accessible from this page.*

Include non-LTER data

LTER sites

AND (176), ARC (1050), BES (591), BNZ (483), CAP (371), CCE (14), CDR (377), CWT (243), FCE (146), GCE (385), HBR (124), HFR (216), JRN (140), KBS (91), KNZ (74), LNO (360), LUQ (124), MCM (205), MCR (67), NIN (117), NTL (198), NWT (149), PAL (40), PIE (352), SBC (160), SEV (213), SGS (74), VCR (185)

animals

fauna (131), macrofauna (15), invertebrates (1163), corals (80), aquatic invertebrates (16), insects (863), microarthropods (9), crustaceans (60), larvae (24), macroinvertebrates (35), mollusks (67), nematodes (49), vertebrates (1046), amphibians (21), birds (189), fishes (360), mammals (471), humans (300), reptiles (37)

atmospheric properties

air quality (19), atmospheric pressure (97), dew point (8), vapor pressure (342), climate (678), microclimate (40), precipitation (893), weather (443), wind (414)

+/- **CAP LTER** *"Point count bird censusing: long-term monitoring of bird distrubution and diversity in central Arizona-Phoenix: period 2000 to 2011" - Shochat Katti Warren*

LTER Identifier:

knb-lter-cap.46.11

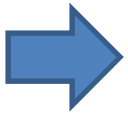
Abstract:

Project Goal: To study the patterns in bird species diversity, abundance and distribution over time and space, and the processes behind these patterns as a result of urbanization.

Owners/Creators:

Shochat Katti Warren

Metadata:



Select here for full metadata

Data File(s):

- 34_birds_1.csv
- 34_surveys_1.csv
- 34_sites_1.csv

Report data

- Simple data will not be easy data to use
- Big (but not too big)
- Clear question in mind?
  - Scientific hypothesis
  - Model testing
- Incorporate real sampling or experimental design constraints
- Incorporate multiple variables
- Time invested in getting good data will pay large dividends later

Background

- Name
- Ecological area
  - E.g. Population ecology, environmental impact assessment, conservation biology…
- Ecological question(s)
  - ?
- Type of statistics
  - ANOVA, spatial, time series, Bayesian…
- Statistical platforms
  - SPSS, STATA, Cran R, ??
- Past statistical experience
  - T-test, Contingency table, ANOVA…