Assessment of Diet and Feeding

ESS 350 Research Methods
Fall 2019

Chapter 17 Fish Techniques
Chapter 21 Wildlife Techniques
Objectives

1. Explain why we should know about diet
2. Describe how to sample for diet contents analysis
3. Discuss what effects diet assessment outcomes
4. Derive indices to quantify diet contents within and among individuals and species
Why?

• Food requirements

• Trophic dynamics

• Spatial and temporal dynamics

• Application to management
What affects diet assessment?

• i.e., what could bias it?
Effects on Diet Assessment

- Time of day

![Bar chart showing number of full stomachs at different times of day](image)
Effects on Diet Assessment

• Season
Effects on Diet Assessment

- Size and territoriality
  - Ontogenetic shifts

- Digestion rate

"More worms? ... Saaaaaaaaay—why are you being so nice to me all of a sudden?"
• Gape limitation
• Predation risk
Effects on Diet Assessment

• Sampling technique
  – Rotenone
  – Gill nets
  – Stress
  – Regurgitation

• Predation in bucket

Sutton et al. 2004

Per cent regurgitation

Mode of capture

Entangled | Wedged | Gilled
Determining diet
Diet collection

- Stomach contents
- Visual
- Scat
- Gastric lavage
- Owl pellets
- Fatty acid analysis
Fatty acid analysis
Fatty acid analysis (Ed McGinley)
Diet collection

• Cost vs. benefits of various techniques
  – Value of the organism
  – Sacrifice and dissect
  – Non-lethal methods
  – Gastric lavage of YOY brook trout (Hafs et al. 2011).
Gut Contents Preservation

- Formalin
- Freezing
- EtOH
- Drying
Diet ID

- Can be tricky to ID
- Study objectives
Describing/Quantifying Diet

STATISTICS

Always remember good scientific study design and study objectives

frog
apple
salmon

Stomach 1; Brown bear

Stomach 2; Black bear

Stomach 2; Brown bear

Stomach 1; Black bear
Describing Diet

1. Frequency of Occurrence

2. Percent Composition by Number

3. Percent Composition by Weight (Wet or Dry)

4. IRI

5. Other Indexes of Diet Composition and Comparisons
Describing Diet

Index of relative importance

• Combines the 3 simple metrics

IRI = (% by number + % by weight) X (% frequency of occurrence)

Do for each diet item

Hard to interpret
Describing Diet

*Selectivity Index* = \( d_i - e_i \)

Large and positive = __________

Large and negative = __________

Near 0 = __________

You are the biologist; therefore you have to qualify it
Diet Comparisons

Schoener Index (1971)

\[ C_{xy} = 1 - 0.5 \left( \sum |p_{xi} - p_{yi}| \right) \]
Schoener’s Index example….

<table>
<thead>
<tr>
<th>Species</th>
<th>Fly</th>
<th>Moth</th>
<th>Gnat</th>
<th>Midge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barn swallow</td>
<td>0.80</td>
<td>0.20</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Bat</td>
<td>0.40</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>Swift</td>
<td>0.10</td>
<td>0.0</td>
<td>0.05</td>
<td>0.85</td>
</tr>
</tbody>
</table>

Calculate it …
Schoener’s Index example….

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<td>0.40</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Calculate it …

\[ C_{xy} = 1 - 0.5 \left( \sum |p_{xi} - p_{yi}| \right) \]

\[
0.4+0+0.2+0.2
\]

1 - 0.5 (0.8)

0.6

60 % diet overlap between the predators
Describing Diet

- Bray Curtis Dissimilarity Index

\[
BC = \frac{\sum_{1}^{n} | (X_{1j} - X_{2j}) |}{\sum_{1}^{n} (X_{1j} + X_{2j})}
\]
Bray-Curtis Dissimilarity Index

- Subtract from 1 to get similarity

\[
BC = \frac{\sum_{1}^{n} |(X_{1j} - X_{2j})|}{\sum_{1}^{n}(X_{1j} + X_{2j})}
\]

<table>
<thead>
<tr>
<th>Predator</th>
<th>Grass Hopper</th>
<th>Deer</th>
<th>Mouse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grey fox</td>
<td>23</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Coyote</td>
<td>5</td>
<td>32</td>
<td>2</td>
</tr>
</tbody>
</table>
20% similarity in diet

Now qualify it in your own words given what you know about the ecology
Bray-Curtis Dissimilarity Index

- More realistic example…

<table>
<thead>
<tr>
<th>Predator Gut Sample</th>
<th>Predator Type</th>
<th>Prey1</th>
<th>Prey2</th>
<th>Prey3</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMB 1</td>
<td>BASS</td>
<td>23</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>LMB 2</td>
<td>BASS</td>
<td>20</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Pike1</td>
<td>PIKE</td>
<td>6</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>Pike 2</td>
<td>PIKE</td>
<td>7</td>
<td>16</td>
<td>3</td>
</tr>
</tbody>
</table>
Compare LMB 1 and LMB 2

\[
\frac{|(23-20)| + |(0-1)| + |(10-7)|}{(23+20)+(0+1)+(10+7)} = \frac{7}{61} \approx 0.11
\]

11% dissimilarity

1 - 0.8 = 89% similarity in diet
## Dissimilarity Matrix

<table>
<thead>
<tr>
<th></th>
<th>LMB1</th>
<th>LMB2</th>
<th>Pike1</th>
<th>Pike2</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMB1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LMB2</td>
<td></td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pike1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pike2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Inferential Statistics for Similarity Analysis

- MeanSim analysis (anosim)
- MeanDist analysis (meandist)
- Analysis of dissimilarity matrices (Adonis)
- Analysis of molecular variance (amova)

- library (vegan)
Basic Idea

- For meandist

Anatomy of a Matrix—between and within group partitions

Grouping vector

Want Bbar >>>> Wbar
Review....

• Calculate frequency of occurrence, percent by number, percent by weight, IRI

• Calculate Schoener’s and BC Index and explain what values mean

• Explain how time of day, time of year, sample gear, digestion rates may influence diet results

• Why is knowing diet important and how do you get it?
Lab: Tasks and Objectives

• Handout for lab
• Quantify the diet of owls from their pellets
  – Practice your forensic ecology skills by identifying small mammals from their skeletal remains
  – Tally up the prey items into a class dataset
  – Calculate indexes to characterize diet (IN EXCEL)
• Compare the diet of owls to another avian predator—the red-tailed hawk
• Learning Goal – apply these analysis techniques to many similar situations

• Note: owl pellets have been made innocuous
  – Discard when done
  – Or save them for posterity
## Class Dataset Looks Like This

<table>
<thead>
<tr>
<th>Obs</th>
<th>Size</th>
<th>Gopher</th>
<th>Rat</th>
<th>Total Large Rodent</th>
<th>Vole</th>
<th>Mice</th>
<th>Total Small Rodent</th>
<th>Shrew</th>
<th>Mole</th>
<th>Bird</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>3</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Data Summary and Analysis

• Summary Stats (i.e., metrics of diet)
  – Percent by number
  – Percent by mass
  – Frequency of occurrence
  – Index of Relative Importance (Combo of the 3 above):
    • $\text{IRI} = (% \text{ by number} + % \text{ by mass}) \times (\text{freq of occurrence})$
  – Graphs

• Diet comparison between potential competitors
  – Barn owl vs. Red-tailed hawk
  – Schoener’s Index

$SI = 100[(1.0 - 0.5(\Sigma |p_{xi} - p_{yi}|))]$
Data Summary and Analysis

– Similarity Analysis (many indexes)
  • Bray-Curtis (Distance) (Subtract from 1 to get similarity)

\[
BC = \frac{\sum_{1}^{n} \left| (X_{1j} - X_{2j}) \right|}{\sum_{1}^{n} (X_{1j} + X_{2j})}
\]
Report for this lab

• Spend the whole lab today finishing
• I’ll collect data up front and email the dataset when finished
• Due next Friday
• Complete the questions/exercises on the handout
• Certainly work together on analyses, but responses to questions must be your own