Comal Springs Riffle Beetle Population Assessment

27 May, 2022
Biological Considerations

• *Heterelmis comalensis*, the Comal Springs riffle beetle (CSRB)
• Larvae take 9 – 11 months to reach maturity
• Wild caught and captively reared adults seldomly live for a year
• Breeding is continuous and likely occurs among different cohorts
Study Design

• Divided into four areas, based off subpopulations of Lucas et al. (2016) + headwaters - TPWD map & supplements (Norris and Gibson)

• Randomly selected 50 springs

• Include 30 HCP biomonitoring sites
  • 19% of mapped spring locations

• Spring Run 4 + Spring Run 5 + Comal headwaters + Blieder’s Creek: 8 sites
Study Design

• Western shoreline + Spring Island: 42 (including 20 biomonitoring sites)

• Some spring sites have almost no flow at this time
Study Design

• Western shoreline + Spring Island: 42 (including 20 biomonitoring sites)

• Spring type divided into upwellings and margin habitats
• **Spring Run 1:** 10 sites

• **Spring Run 3:** 20 (including 10 biomonitoring sites)
Covariates

Spring-level covariates
- Temperature, DO, Conductivity, days deployed, biofilm category, Wentworth substrate, spring type
- Flow index
  - Areas < 10 x 10 cm find left-center-right flow of that area
  - Complex areas > 10 x 10 cm will use Heron’s formula, find flow at center of each triangle

Sampling-event-level covariates
- Cumulative precipitation, subpopulation, Julian Days
Lure efficacy

Previous study
• Found ca. 20% of adults would reside on poly-cotton lures in laboratory settings
• High variability

Current study
• Place five lures at select locations where CSRB is expected to be found but not part of the study
• Count and replace beetles after 30 days and replace one lure in same area
• Return to lure site after a few days and count beetles on the same lure
• 100% efficacy = same number of beetles found on one lure as all five
Analysis

N-mixture models

• Issues with model assumptions (immigration/emigration, life-history)
• True sample replication is unlikely
• Open N-mixture model likely unsuitable for insect populations that display over dispersion
• We can provide exploratory analysis with open N-mixture models

General linear mixed models (GLMM)

• Non-independent, structured data at hierarchal levels
• Quantify spatiotemporal patterns
• Fixed effects and random effects
Analysis

GLMM procedures

1. Selection of population metrics and Exploratory analysis
   - Population metrics – presence/absence, relative abundance
   - Exploratory analysis – summary statistics, data visualization
     - What type of variation occurs within variables?
     - What type of covariation occurs between variables?

2. Present statistical models
   - Choose error distribution
   - Select fixed effects
   - Select random effects
     - Random intercepts model
     - Random intercepts and slopes model

3. Pre-process data
   - Remove highly correlated and near-zero variance predictors variables, transformations (if needed)

Figure 1; Harrison et al. 2018
Analysis

GLMM procedures

4. Fit and validate model
   • Model diagnostics checks
   • Model uncertainty checks

5. Model selection and evaluation
   • Select parsimonious model
   • Evaluate out-of-sample predictive performance

6. Model interpretation
   • Predictive performance
   • Predictor relative importance
   • Parameter estimates
   • Partial dependence plots
Sample schedule

• Schedule A:
  • Four sampling events over 11-month period
  • September 2022; concluded in August 2023

• Schedule B:
  • Four sampling events based on biomonitoring schedule
  • September 2022; concluded May 2024

• What about drought conditions?
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Questions?