

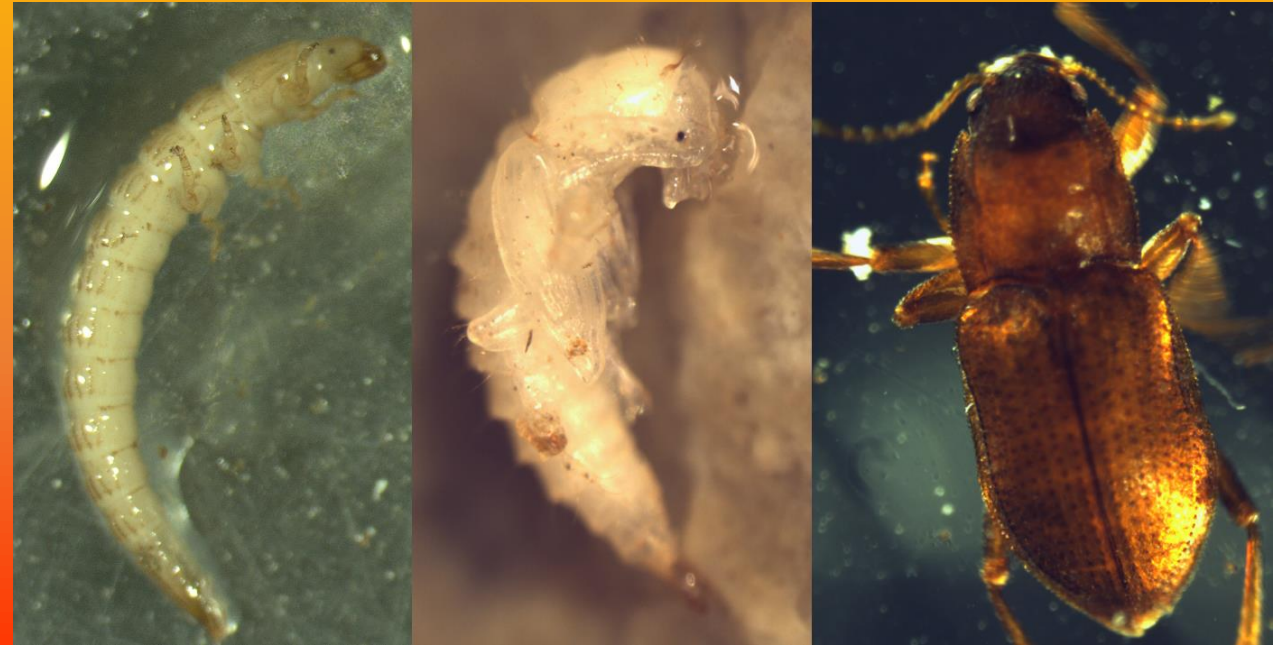
# Comal Springs Riffle Beetle Population Assessment



27 May, 2022

# Biological Considerations

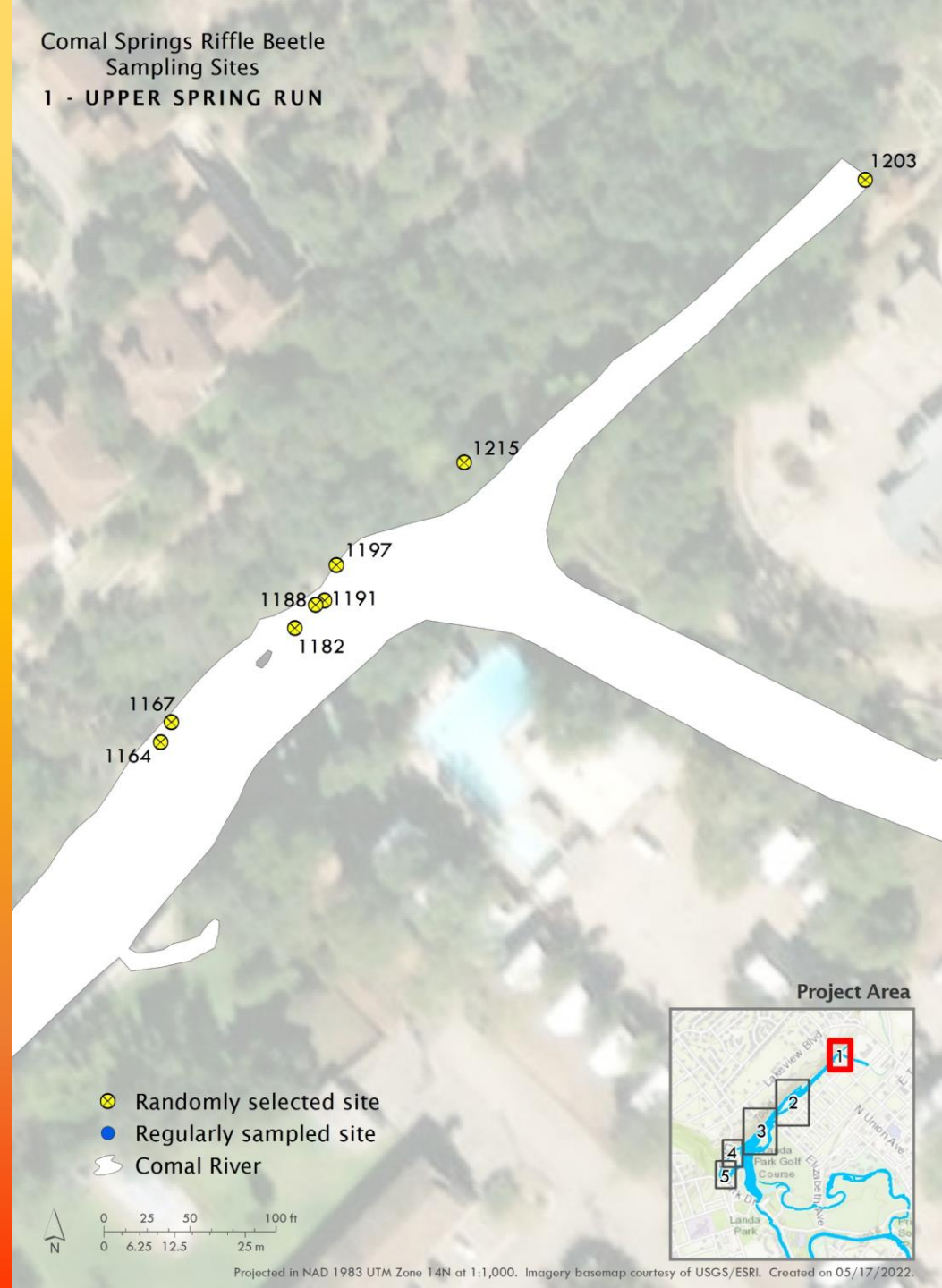
- *Heterelmis comalensis*, the Comal Springs riffle beetle (CSRB)
- Larvae take 9 – 11 months to reach maturity
- Wild caught and captively reared adults seldomly live for a year
- Breeding is continuous and likely occurs among different cohorts





# Study Design

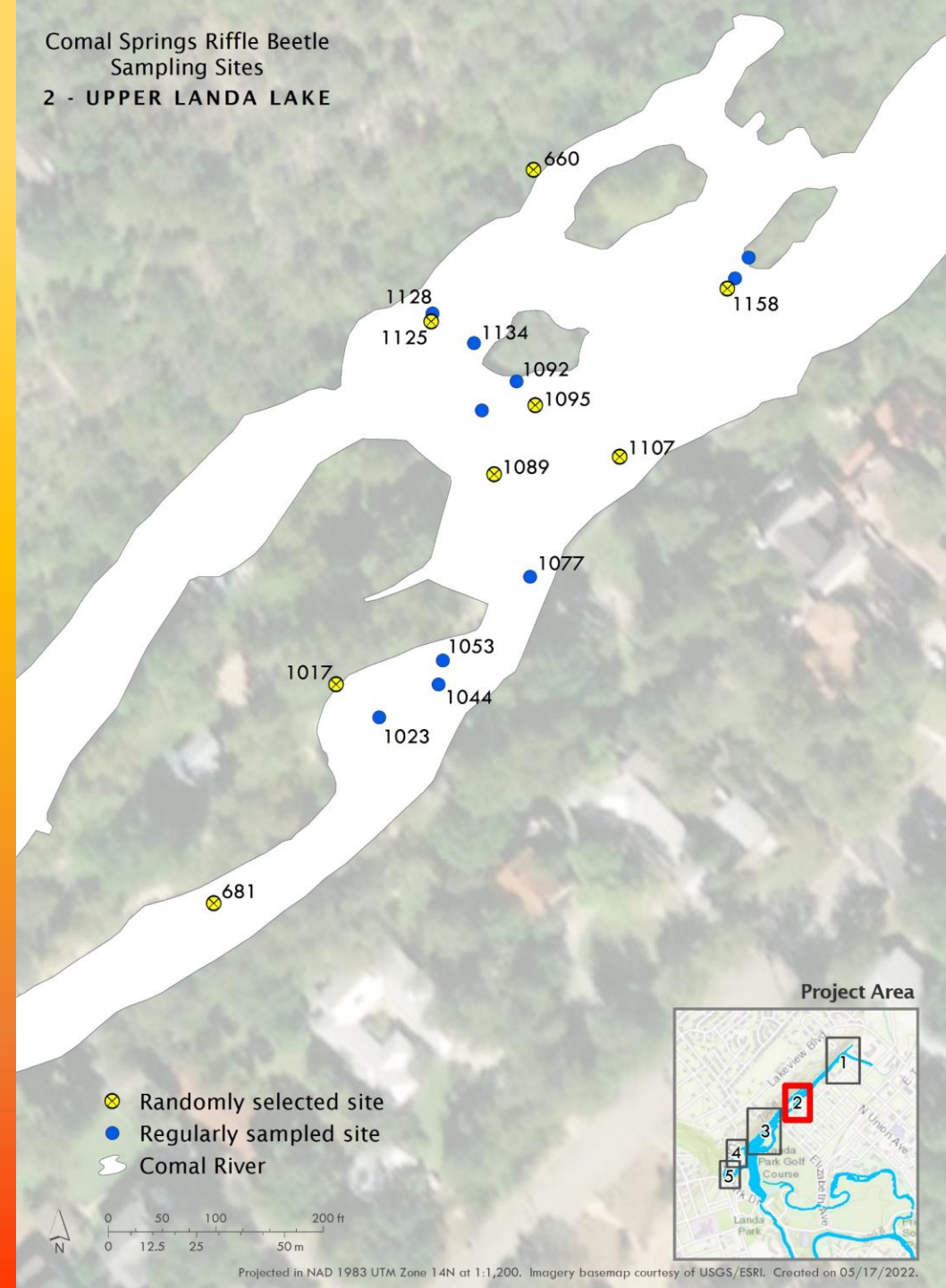
- Divided into four areas, based off subpopulations of Lucas et al. (2016) + headwaters - TPWD map & supplements (Norris and Gibson)
- Randomly selected 50 springs
- Include 30 HCP biomonitoring sites
  - 19% of mapped spring locations
- Spring Run 4 + Spring Run 5 + Comal headwaters + Blieder's Creek: 8 sites



# Study Design

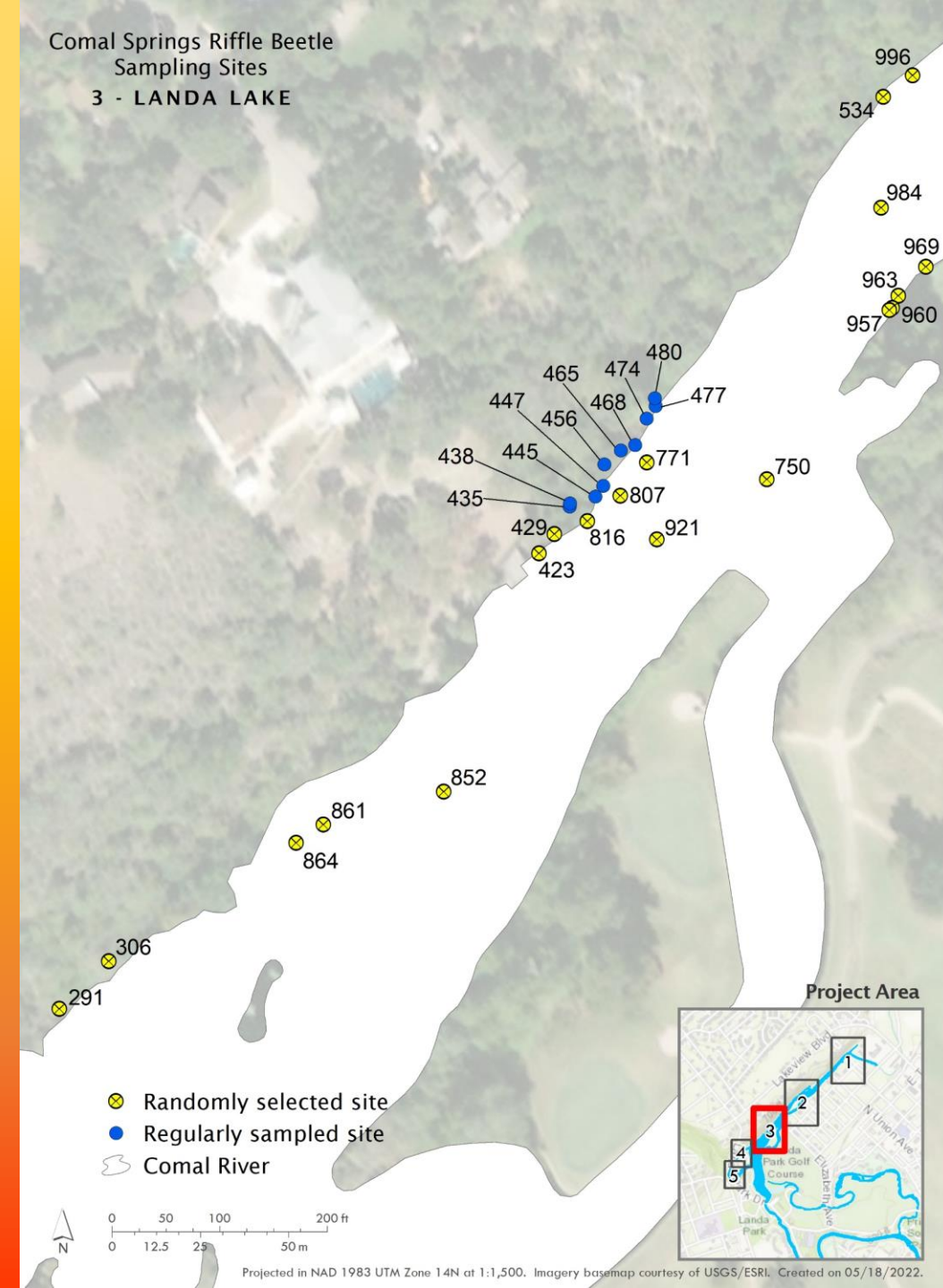
- Western shoreline + Spring Island: 42 (including 20 biomonitoring sites)
- Some spring sites have almost no flow at this time

Comal Springs Riffle Beetle  
Sampling Sites  
2 - UPPER LANDA LAKE



# Study Design

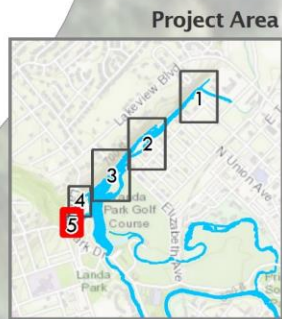
- **Western shoreline + Spring Island: 42 (including 20 biomonitoring sites)**
- **Spring type divided into upwellings and margin habitats**





Comal Springs Riffle Beetle  
Sampling Sites  
5 - SPRING RUN 1

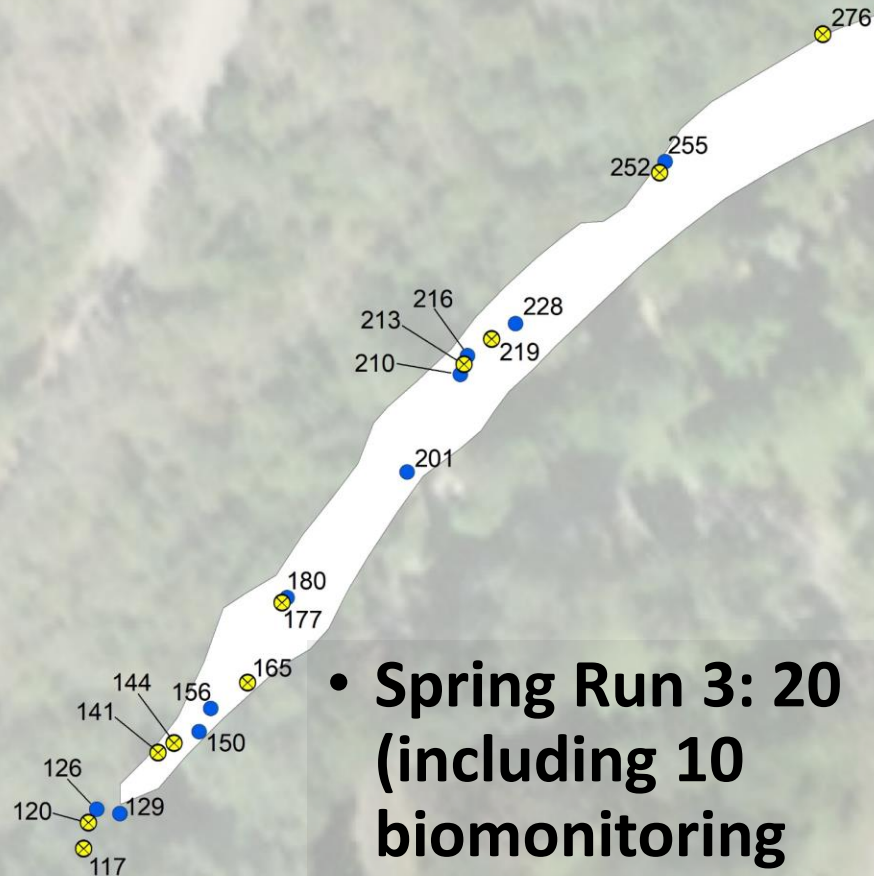
# • Spring Run 1: 10 sites



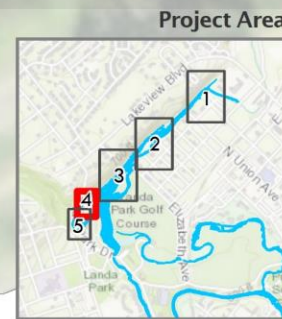
Projected in NAD 1983 UTM Zone 14N at 1:750. Imagery basemap courtesy of USGS/ESRI. Created on 05/18/2022.

# Study Design

Comal Springs Riffle Beetle  
Sampling Sites  
4 - SPRING RUN 3



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



Projected in NAD 1983 UTM Zone 14N at 1:800. Imagery basemap courtesy of USGS/ESRI. Created on 05/18/2022.





# Covariates

## Spring-level covariates

- Temperature, DO, Conductivity, days deployed, biofilm category, Wentworth substrate, spring type
- Flow index
  - Areas  $< 10 \times 10$  cm find left-center-right flow of that area
  - Complex areas  $> 10 \times 10$  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)

Examples of random intercepts and random intercepts/slopes models

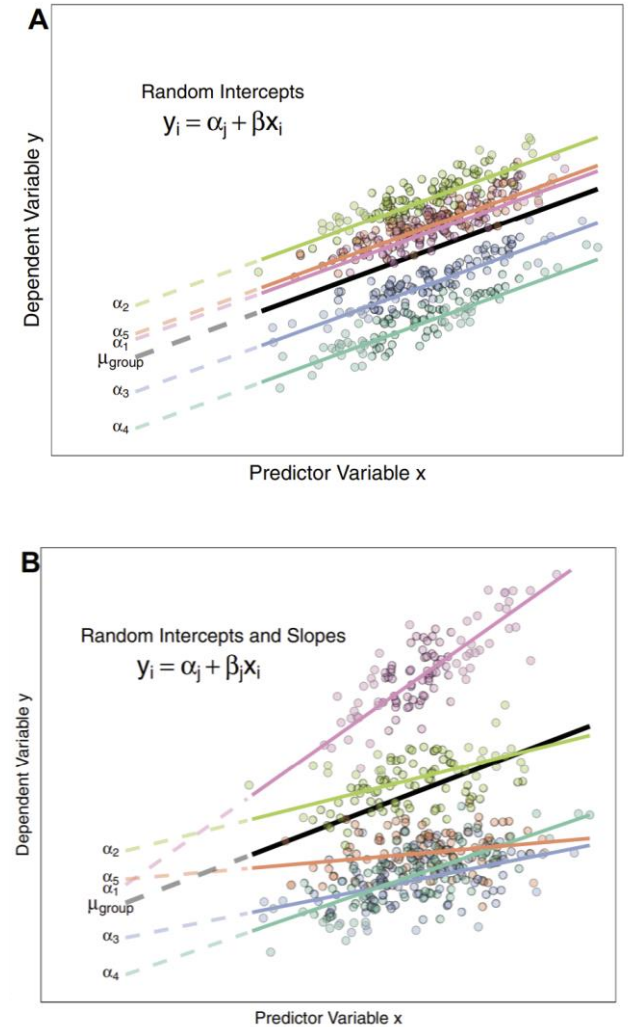


Figure 1; Harrison et al. 2018



# 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?**





# Comal Springs Riffle Beetle Population Assessment

**Questions?**