Status of Native Bumblebees (*Bombus* spp.) at Fort Riley Military Reservation, Kansas

The proposed study aims to assess the diversity and abundance of native bumblebee (Bombus spp.) populations at Fort Riley Military Reservation in Kansas, focusing specifically on the American bumblebee (*Bombus pensylvanicus)* and the Southern Plains bumblebee (*Bombus fraternus*). With the steady decline of these species, particularly in the Great Plains region, this research will provide insight into the influence of habitat management practices and landscape composition on bumblebee communities in the tallgrass prairie ecosystem.

Objectives: The primary objectives are (1) to measure the variation in bumblebee communities across different land cover types, floral types, and management regimes; (2) to evaluate environmental factors affecting bumblebee density and abundance using distance sampling methods; and (3) to establish a causal link between floral resource availability and pollinator density at local habitat scales using mark-recapture sampling.

Study Design: This research involves a multi-scale assessment using three core methodologies. First, a community composition analysis across different land covers will track bumblebee diversity in response to floral types, stages, and management regimes (e.g., prescribed burns, haying). Second, landscape-level distance sampling will estimate the abundance and density of bumblebee populations and relate them to various environmental and management factors. Lastly, a local variable assessment using mark-recapture trials will identify correlations between floral resource availability and bumblebee density. Key variables include seasonal floral abundance, environmental management practices, and specific habitat conditions.

At the landscape scale, I will use distance sampling to:
(1) estimate the abundance and density of native bumblebee populations;
(2) assess occurrence, abundance, and distribution of native bees on Fort Riley, and evaluate the potential effects of these factors on future military missions;
(3) evaluate effects of various management actions, such as tree removal, fire (including time since burned), and haying on pollinator density.

Distance Sampling Methods and Design: Because this study will occur over 3 years of seasonal data collection, I will group characteristics based on time periods and conduct a variable assessment to compare and contrast overlapping time frames.

- Three sampling years; 2022, 2023, 2024.
- Two bouts per sampling year: Bout 1 (May 1 - June 30) and Bout 2 (July 1 - August r 31).

Distance sampling surveys were conducted along 151, 500-m transects randomly deployed within Training Units of the study area. We conducted sampling during early summer (May and June) and late summer (July and August). Each transect was surveyed for bees once per bout.

Observers record the perpendicular distance from the transect to each detected bumblebee and other relevant data such as the time of observation and environmental conditions. Distance measurements will be used to fit a detection function, which describes how detection probability declines with increasing distance from the observer. Package Distance in Program R will be used to estimate parameters of the detection function and calculate bumblebee density across the surveyed area, within certain cover types, and by management action (e.g., tree removal, fire, time since burned, haying). The resulting bumblebee density estimate will be used in conjunction with linear models to evaluate potential relationships with vegetation and landscape characteristics. The primary purpose of distance sampling is to provide unbiased estimates of animal density and abundance by accounting for detectability of individuals within a survey area. By modeling this relationship, distance sampling can correct the bias introduced by the likelihood of missing individuals farther away from the observer.

Expected Outcomes: This study hypothesizes that bumblebee abundance and diversity will differ by land cover and management types, with higher densities associated with diverse floral resources and reduced land-use intensity. Areas with high floral resource density are expected to show higher pollinator densities, establishing floral resources as critical to local bumblebee populations. The results will offer insights into management strategies for tallgrass prairie ecosystems, enabling adaptive conservation measures for pollinator health and biodiversity on military lands.

Through this study, Fort Riley's ecological management practices will be assessed to inform conservation planning and support the sustainable coexistence of bumblebee populations with military operations, contributing to regional conservation strategies for vulnerable pollinator species.

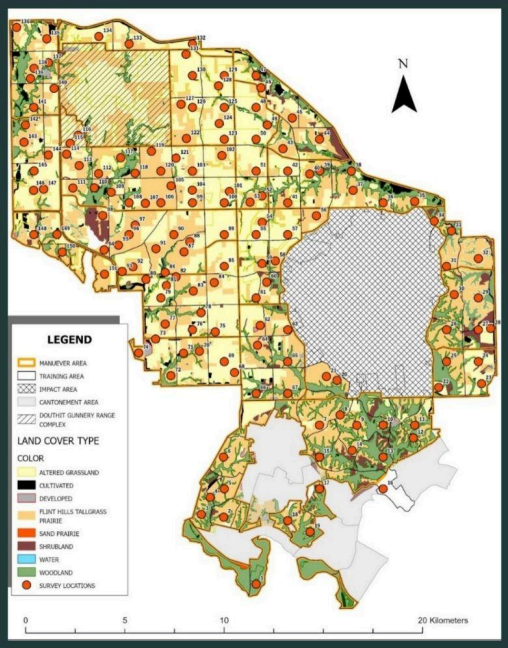
Distance Sampling

Randomized Survey Locations

- Density estimates of *Bombus* populations on **entire** installation
- 151 transects total, 500-m long
- Two survey efforts
  - Bout 1: May 1 - June 30
  - Bout 2: July 1 - August 31

Vegetation Surveys (Landscape Scale)

- 5 vegetation points per transect
  - Robel Pole: VOR
  - Daubenmire Frame: Vegetation cover
- Plot GPS points of bumblebees
  - ID to species - visual observations



Field Methods - Distance Transect

1. Record weather measurements, start time, observer, and transect ID

2. Traverse pollinator transect on foot at no more than 4 mph

3. Collect coordinates of all observed bumblebees using Trimble

4. Record stop time at end