Changes in Insect Pollinator Phenology Across a Gradient of Anthropogenic Change in Florida

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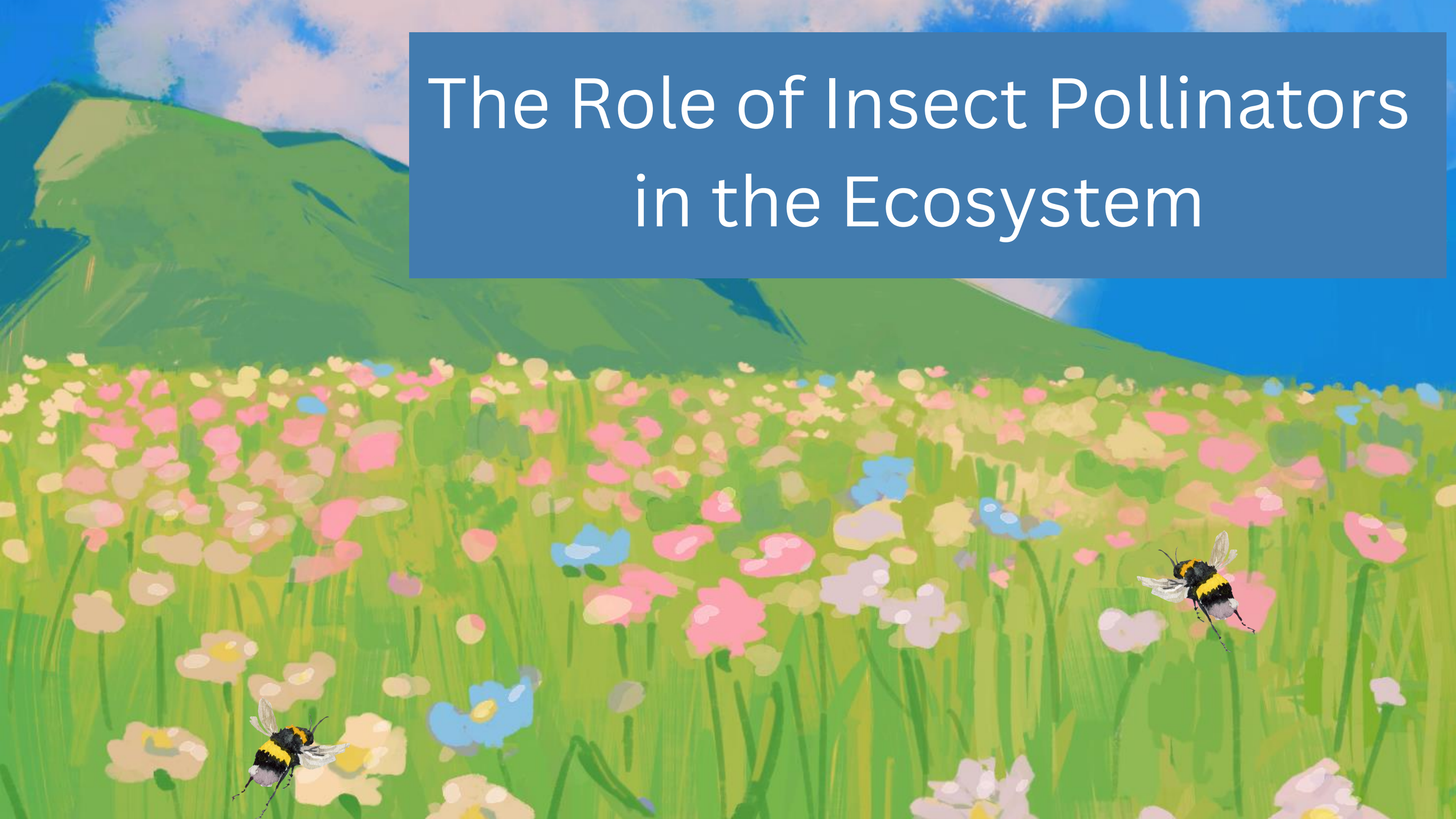
The Role of Insect Pollinators in the Ecosystem



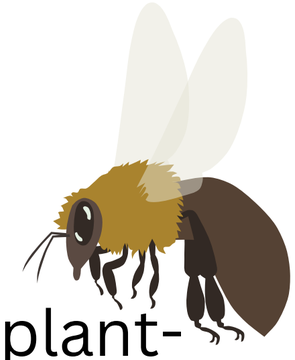
Tilling and Aerating Soil

Aiding in Decomposition


Abundant Food Source

Pollination

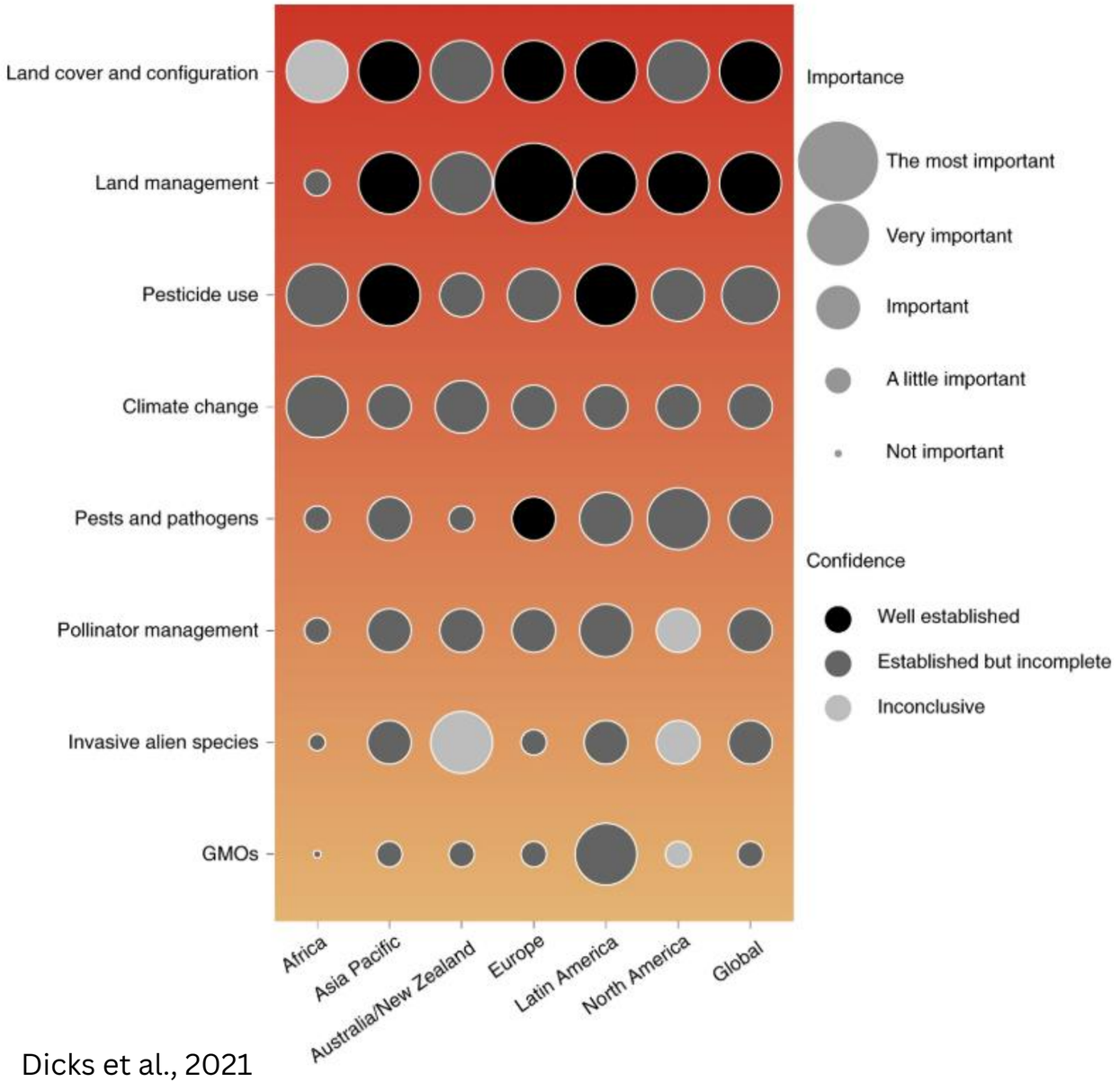
Food and Agriculture Organization
of the United Nations



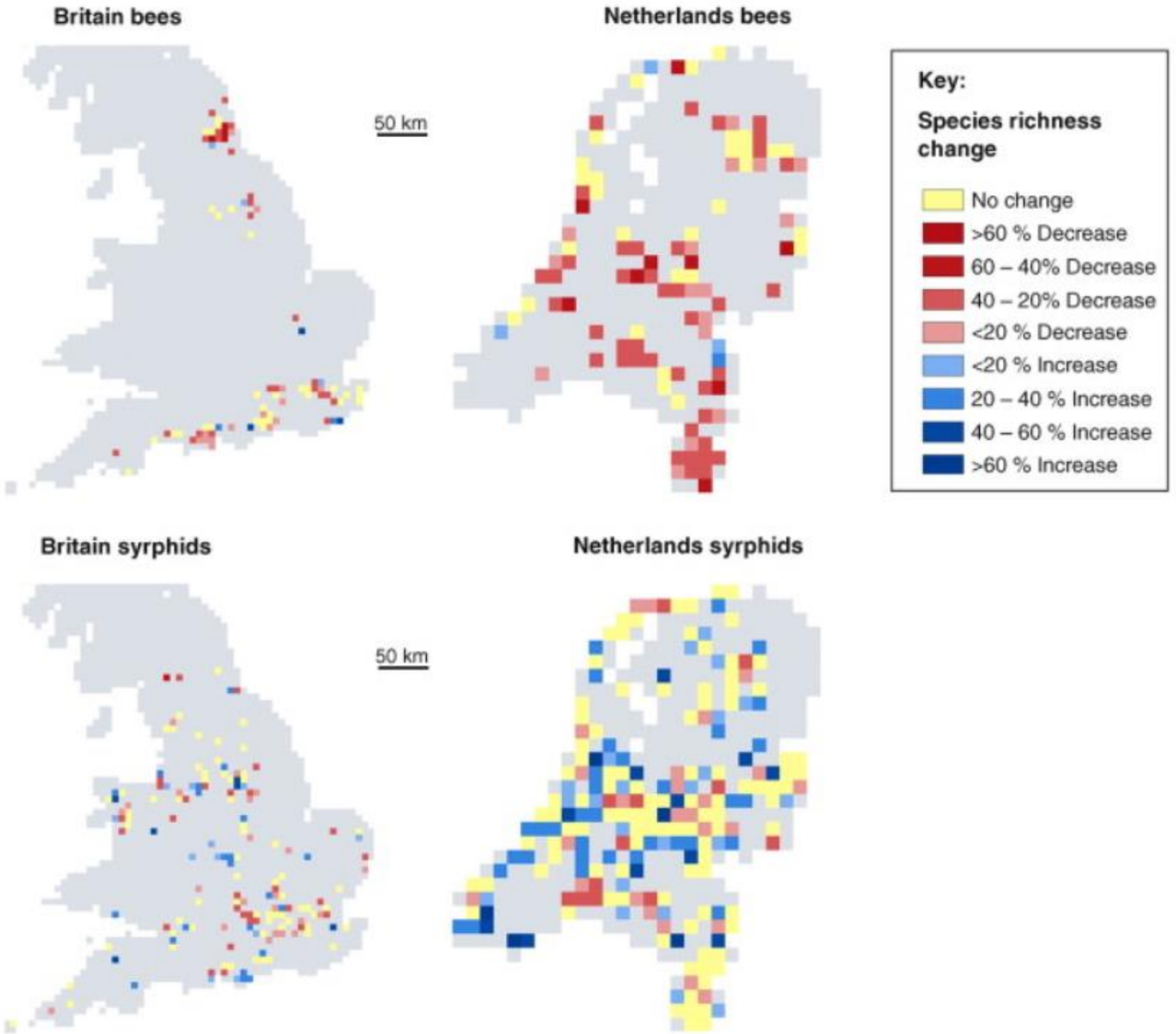
“About two thirds of the crop plants that feed the world, plus many plant-derived medicines in our pharmacies, rely on pollination by insects or other animals to produce healthy fruits and seeds. Of the slightly more than 100 crop species that provide 90 percent of national per capita food supplies for 146 countries, 71 species are bee-pollinated (but relatively few by honeybees), and several others are pollinated by thrips, wasps, flies, beetles, moths and other insects.”

— FAO. (2004). Conservation and management of pollinators for sustainable agriculture—The international response.

Urban Factors Have Been Linked to Insect Pollinator Declines



Dicks et al., 2021



TRENDS in Ecology & Evolution

Potts et al.,

Fig. 3: Environmental drivers of insect OTU richness in rural and urban ecosystems.

Insect taxa	Ecosystem	Spatial scale of response to habitat	Environmental drivers	Directionality of effect
Diptera	Rural	250 m	Local flower richness	↑
	Urban	250 m	Edge density	↑
			Residential cover	↑
Lepidoptera	Rural	250 m	Local flower richness	↑
	Urban	Not modelled	Not modelled	
Coleoptera	Rural	1000 m	Local flower richness	↑
			Habitat diversity	↑
	Urban	1000 m	Habitat diversity	↑
Hymenoptera	Rural	1000 m	Edge density	↑
			Proportion of arable land	↓
	Urban	1000 m	Edge density	↑
Bees (Anthophila)	Rural	1000 m	Edge density	↑
			Proportion of arable land	↓
	Urban	1000 m	Edge density	↑

While the richness and abundance of Hymenopterans and generalist pollinators increases in cities, the opposite is true for Dipterans, Lepidopterans, and specialist pollinators (Theodorou et al., 2020)

Urbanization can have negative, positive, neutral, or mixed effects on pollination (Silva et al., 2023)

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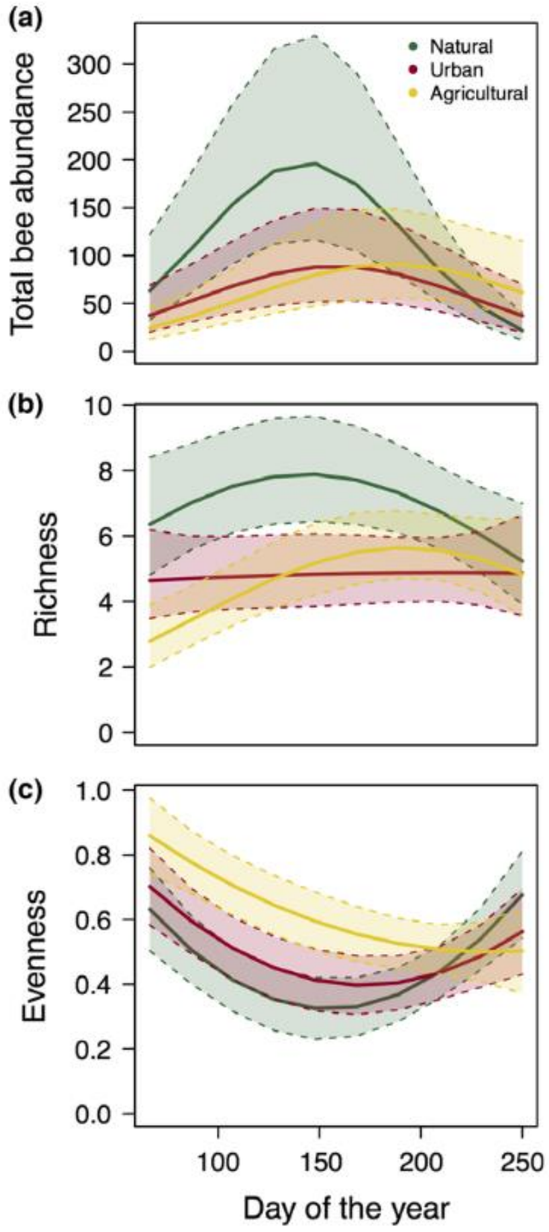
While the richness and abundance of Hymenopterans and generalist pollinators increases in cities, the opposite is true for Dipterans, Lepidopterans, and specialist pollinators (Theodorou et al., 2020)

By 2050, more than two-thirds of the world's population is expected to live in cities (Gerten et al., 2019)

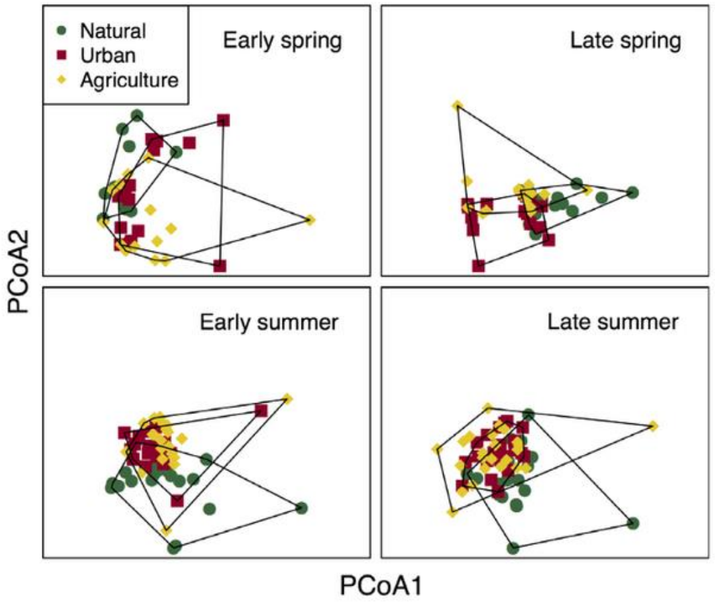
Urbanization can have negative, positive, neutral, or mixed effects on pollination (Silva et al., 2023)

Most urban pollinator studies are conducted in temperate cities of Europe and North America (Silva et al., 2021)



Leong et al., 2016

Some studies suggest that urbanization can shift pollinator phenology – in this case, flight period. These studies, however, are mostly focused on bees and small in spatial scale.



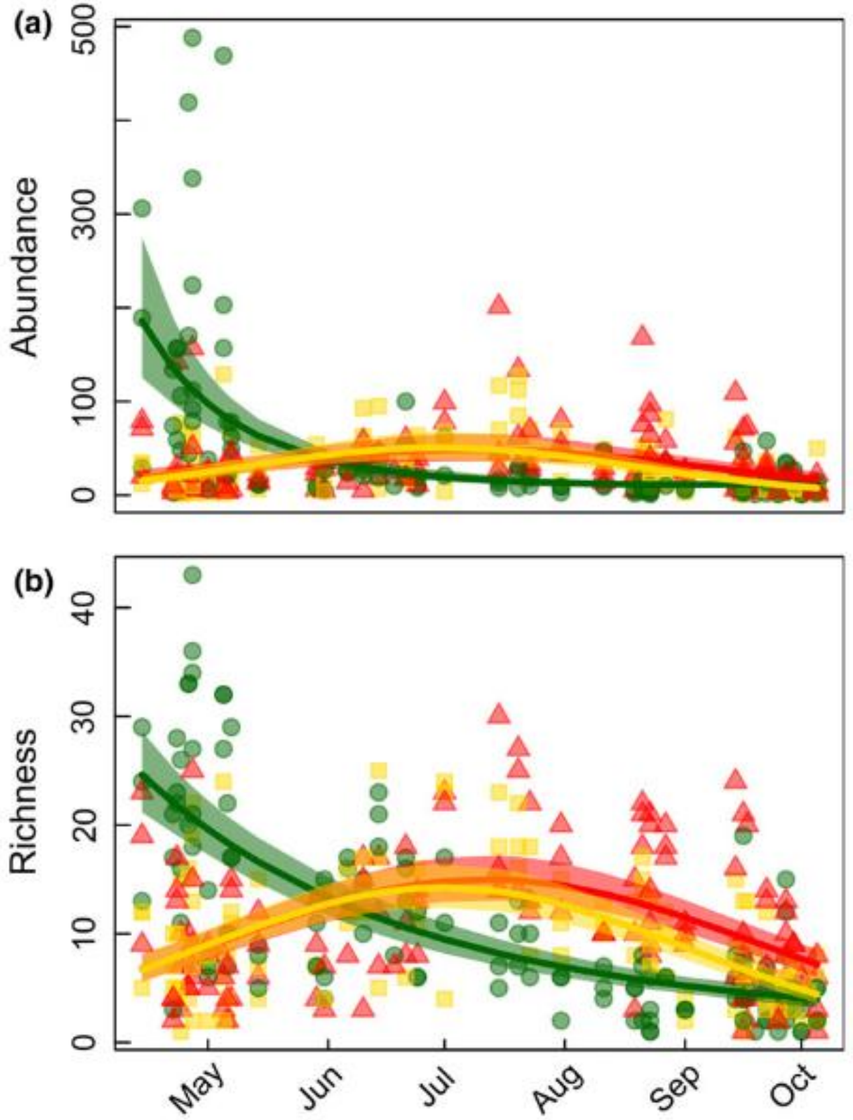


FIGURE 1 Abundance (a) and species richness (b) of bees change throughout the season differently within forest sites (green circles) vs. within agriculture and urban sites (yellow squares and red triangles). Each point represents one site visit (N = 36 sites visited 11 times). Fitted model curves are surrounded by calculated 95% CI

Harrison et al., 2018

Missing from the studies

- An overview of the phenology of many insect pollinator species in urban and non-urban areas-- not just bees-- using a large data set

What We Would Like to Know:

- Will these same patterns emerge over a larger geographic scale and with a larger dataset?
- Will there be variation by taxonomic and functional groups?

Research Objective:

To assess pollinator phenology as a function of anthropogenic change across taxonomic scales.

Hypotheses:

A) Anthropogenic change will be a significant predictor of pollinator phenology.

B) The pollinator phenological response to urbanization will vary by taxanomic and functional group.

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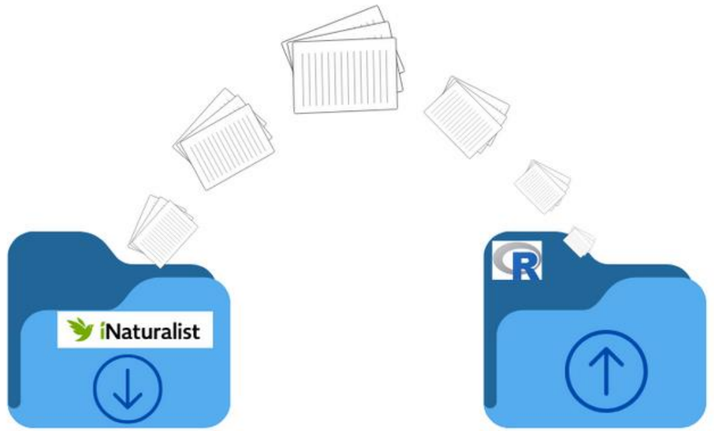
Methodology Work Flow

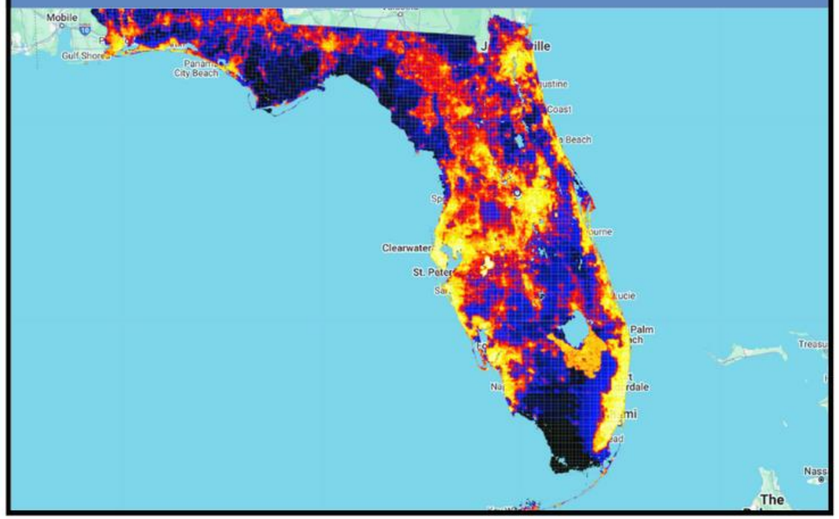
A

Download pollinator data from iNaturalist 2008-2024



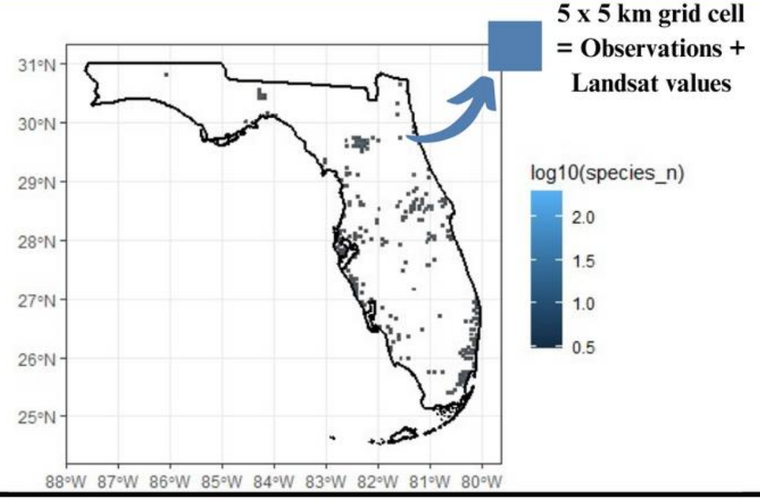
B

Collect Landsat data of Florida from the Google Earth Engine GHMI Data Set



C

Sort observations and Landsat data into 5 km grid cells of Florida



D

Filter Data

✓ Research Grade

≥ 10 observations per grid

≥ 3 species per grid

E

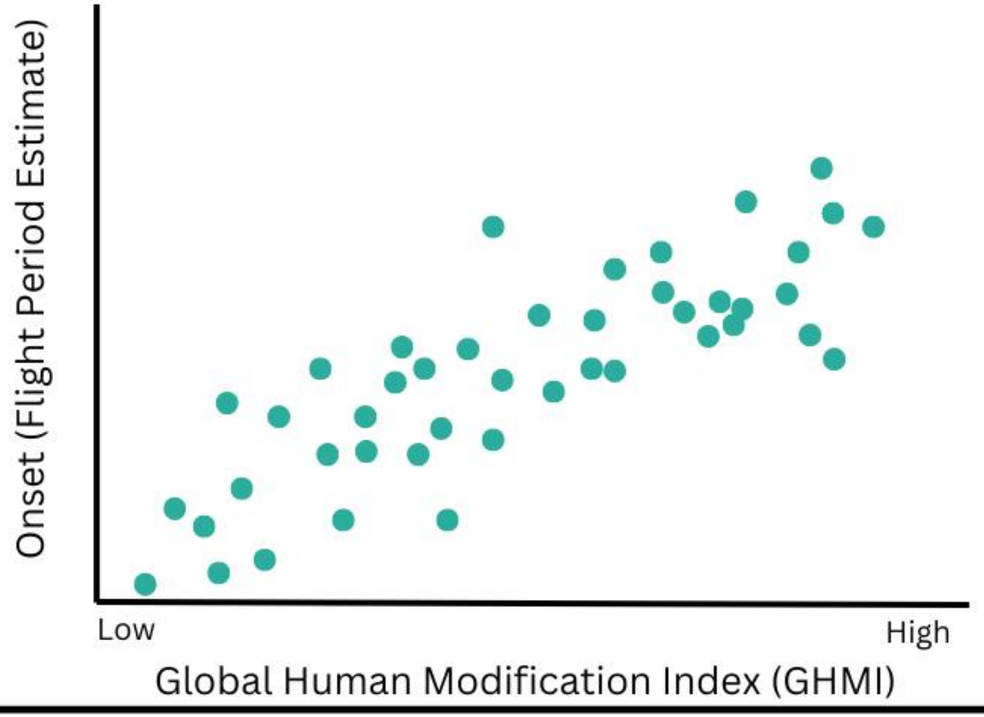
Utilize the phenesse R package to obtain phenological estimates

Flight Period

Onset Offset Total Duration

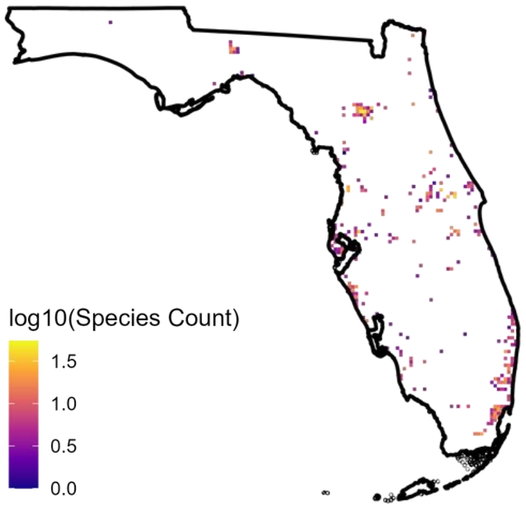
F

Utilize GAMs to assess phenology across anthropogenic/geographic gradients



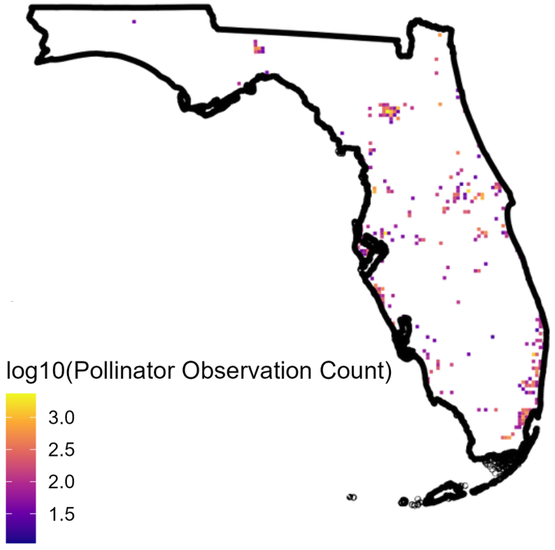
A

Number of Species per Grid Cell



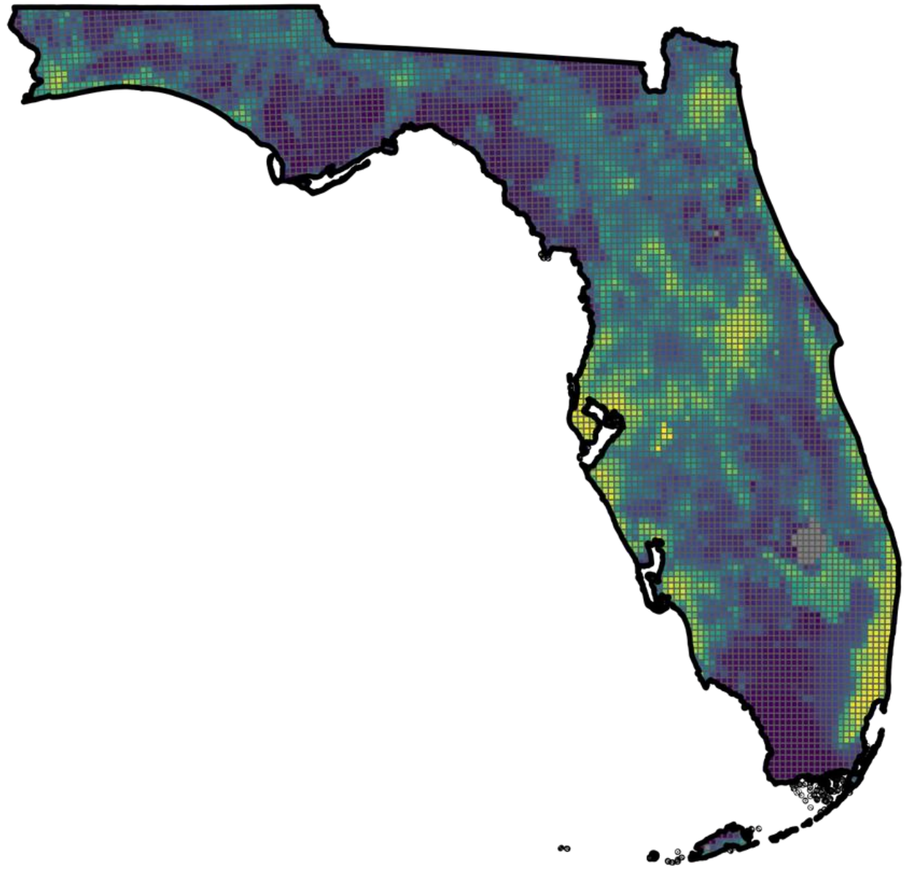
B

Number of Observations per Grid Cell



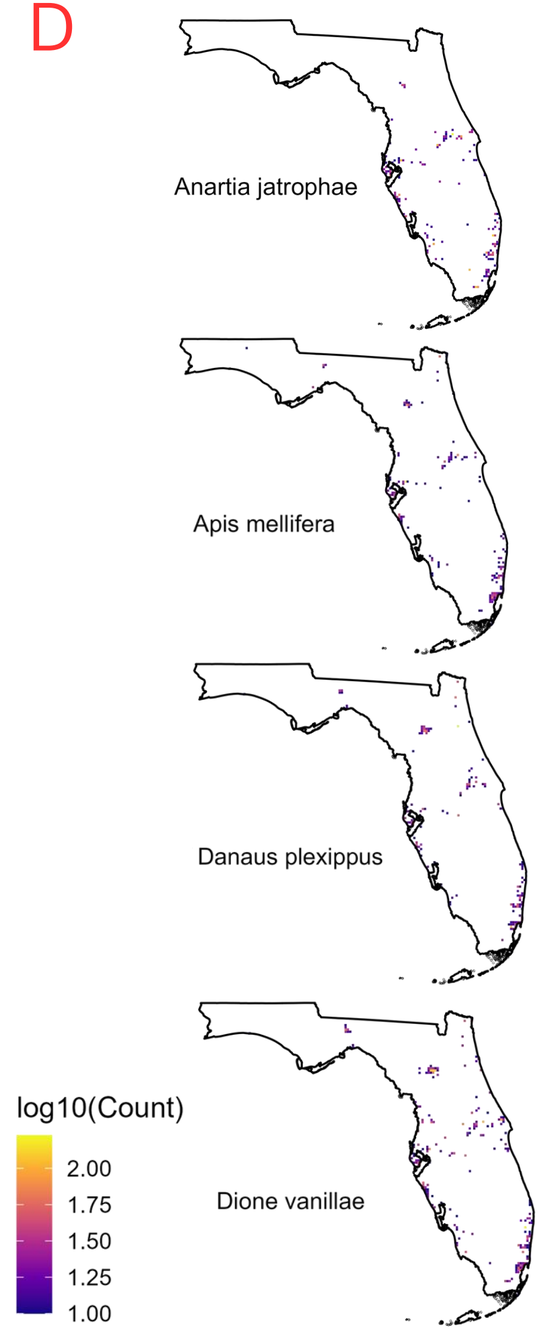
C

Anthropogenic Change Across Florida (GHMI)



D

Observations per Grid Cell



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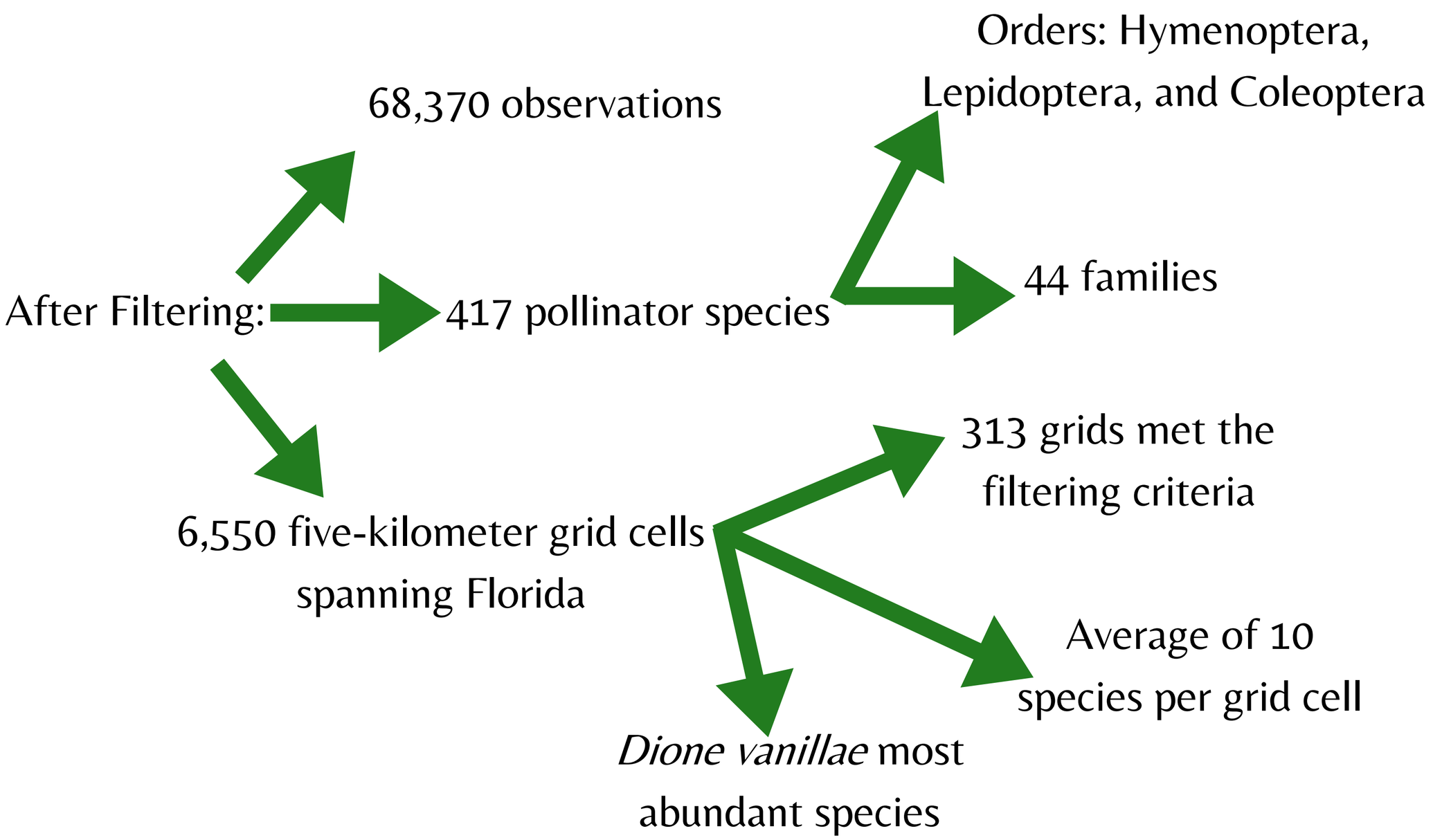
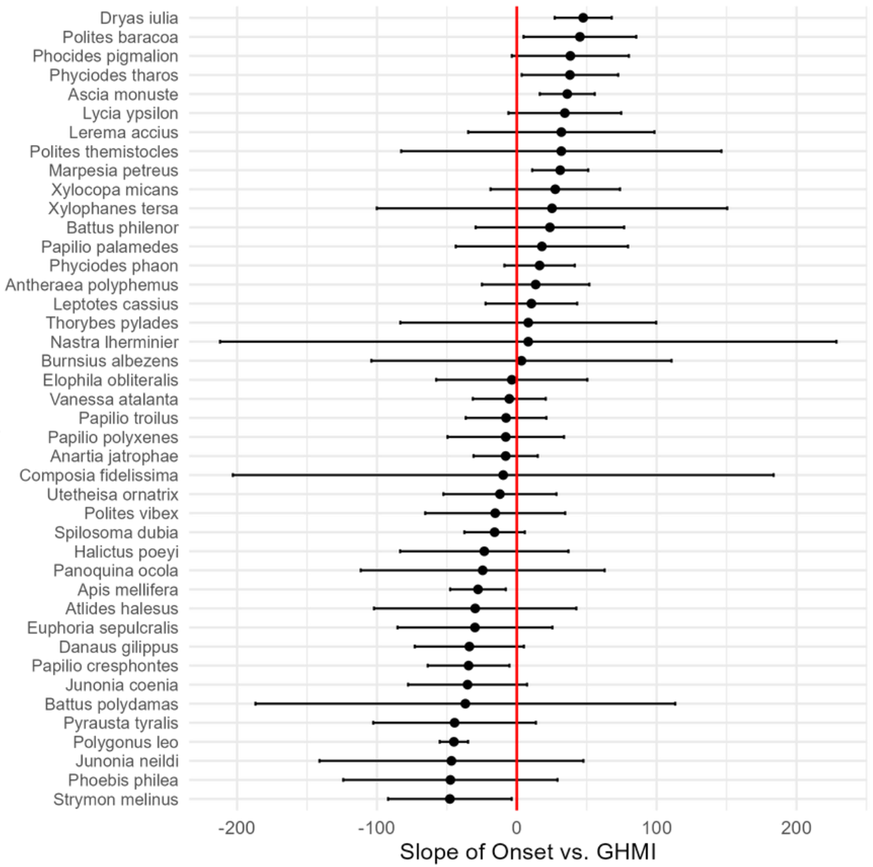
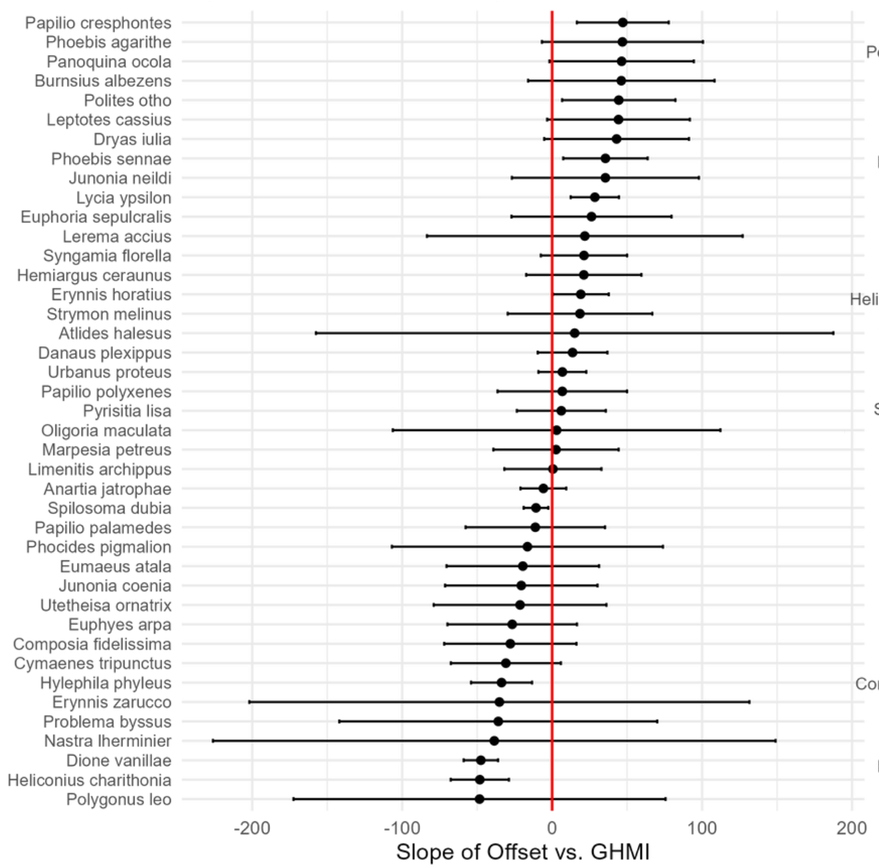
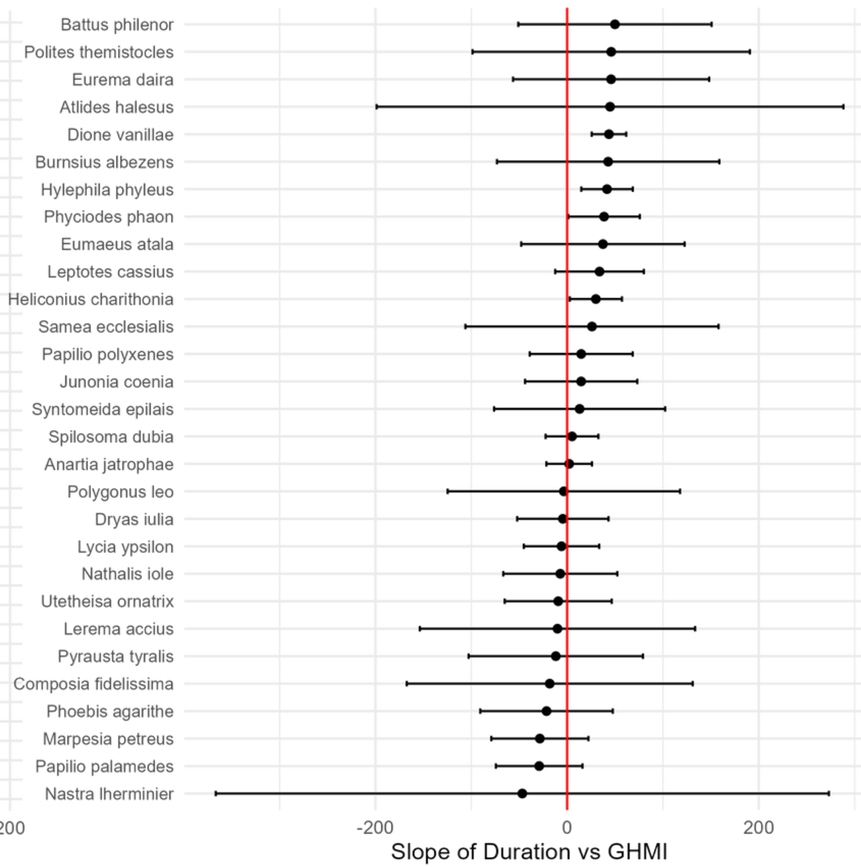
Data Composition:



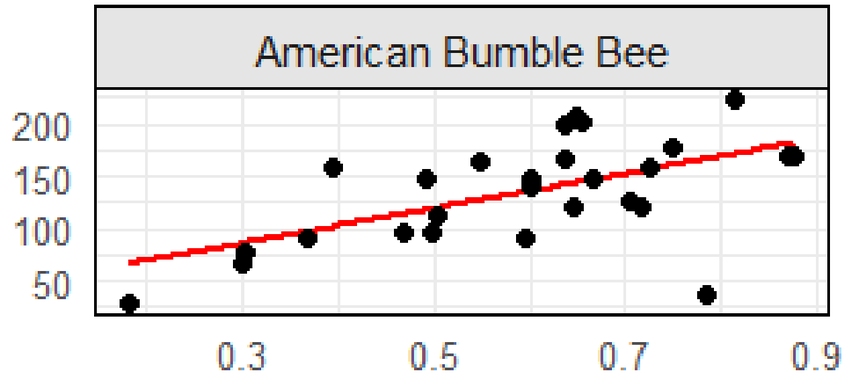
Flight Period Estimates Across a Range of GHMI Values

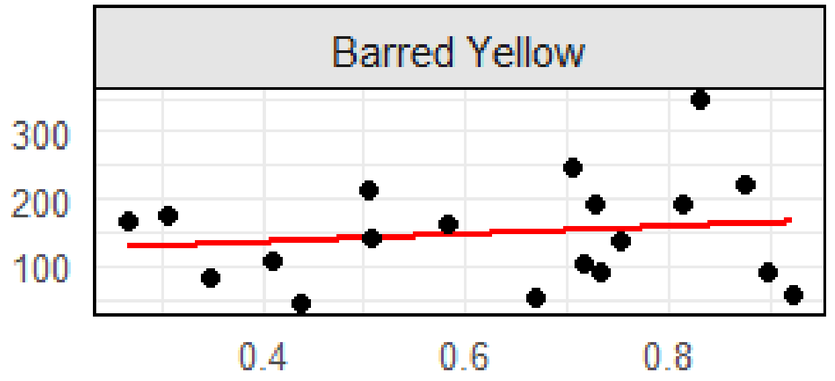


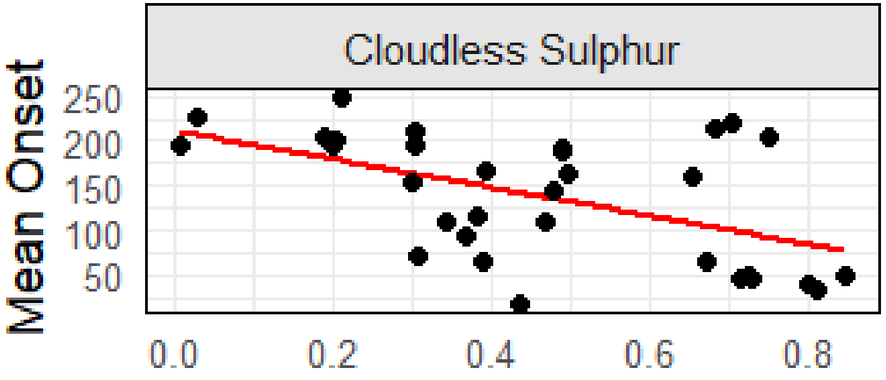


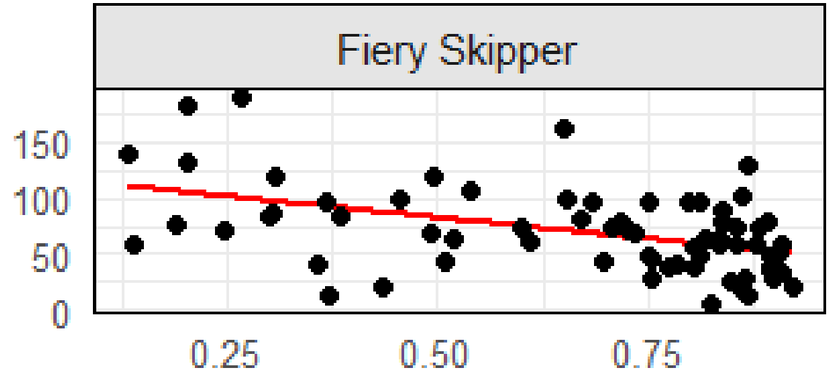


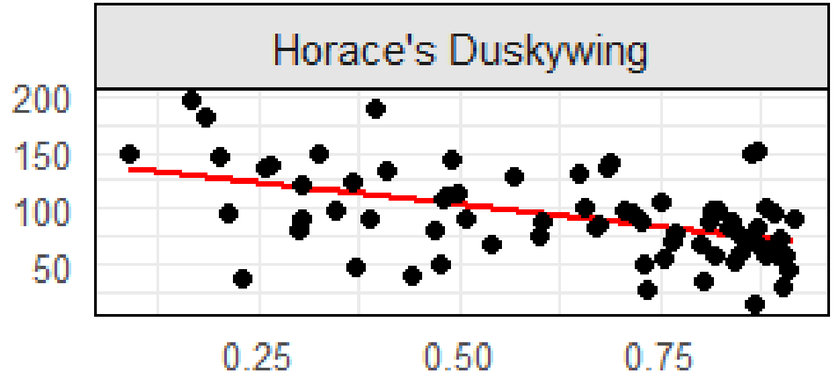
Mean Onset of Flight Period Across GHMI for Selected Species

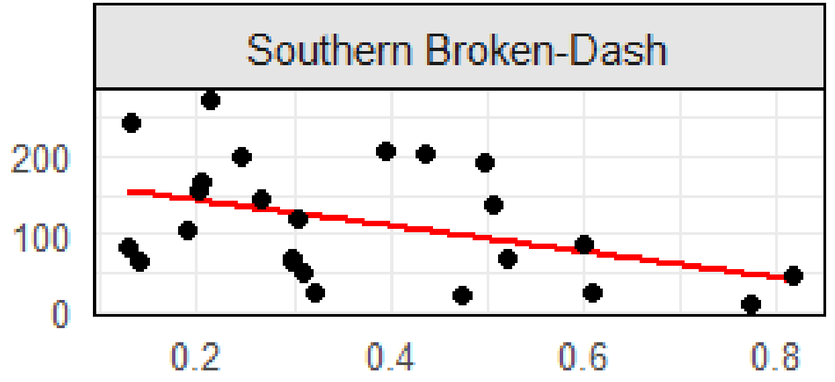






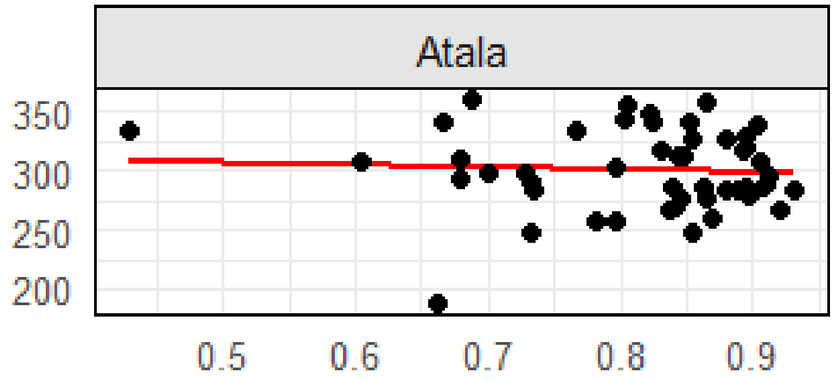


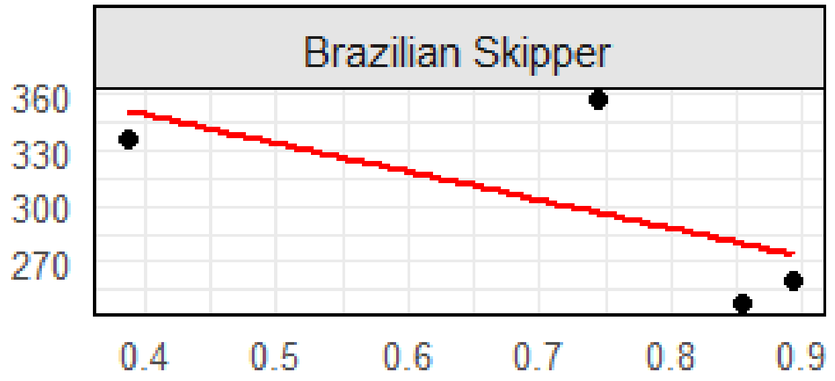


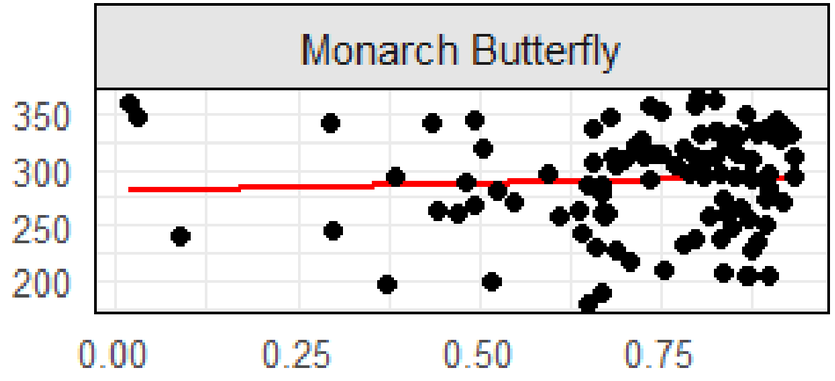


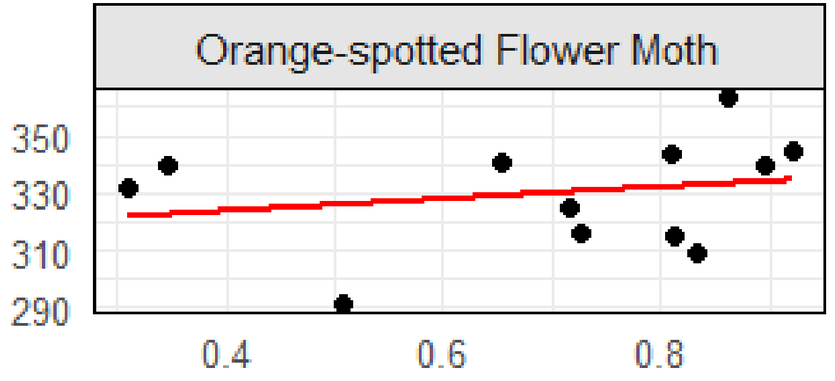
GHMI

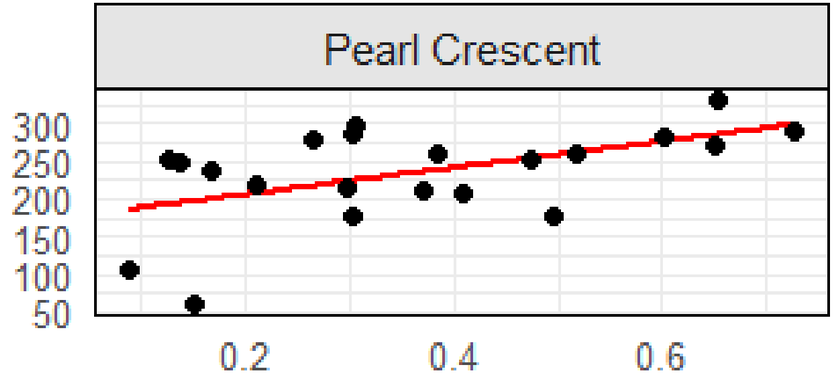
Mean Offset of Flight Period Across GHMI for Selected Species

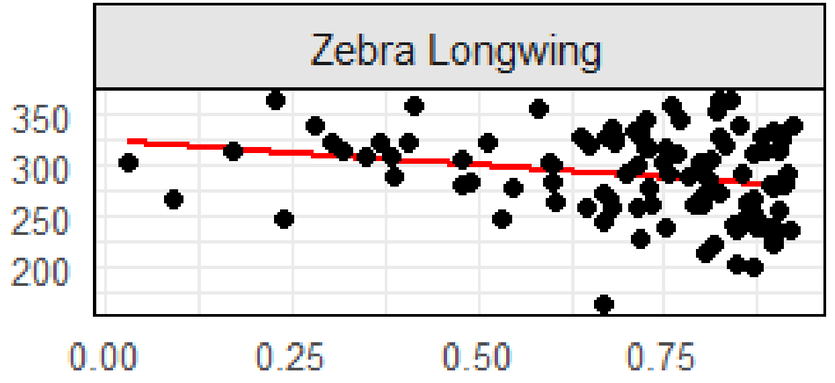






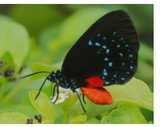


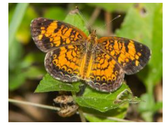


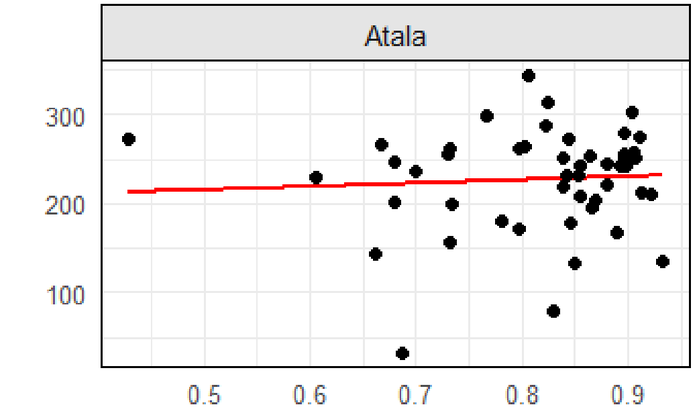


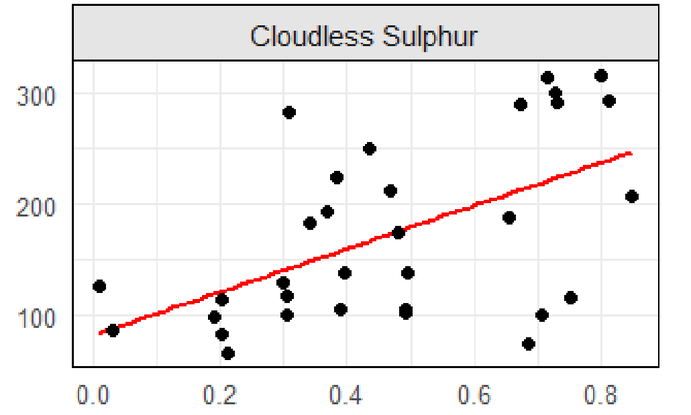
GHMI

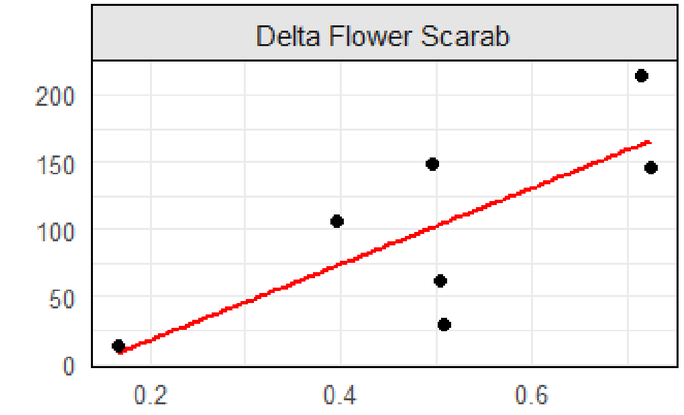
Mean Duration of Flight Period Across GHMI for Selected Species

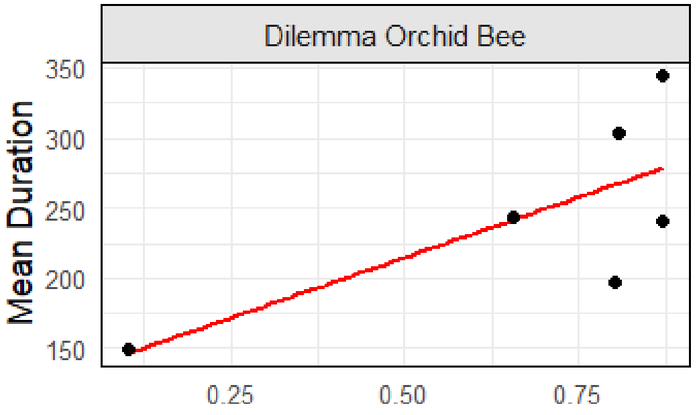


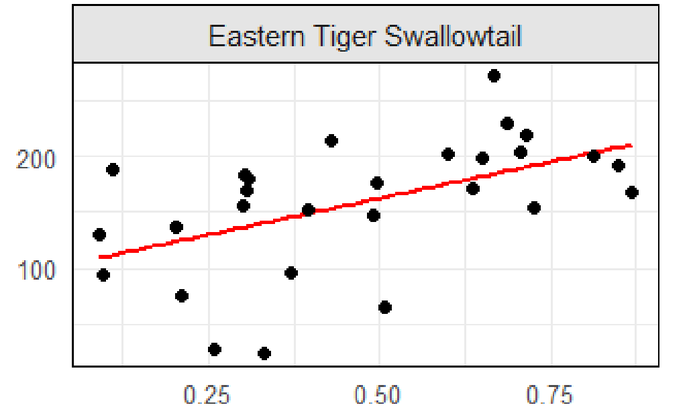


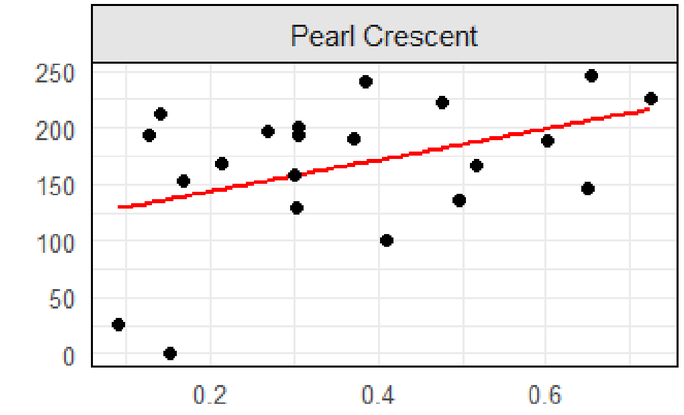


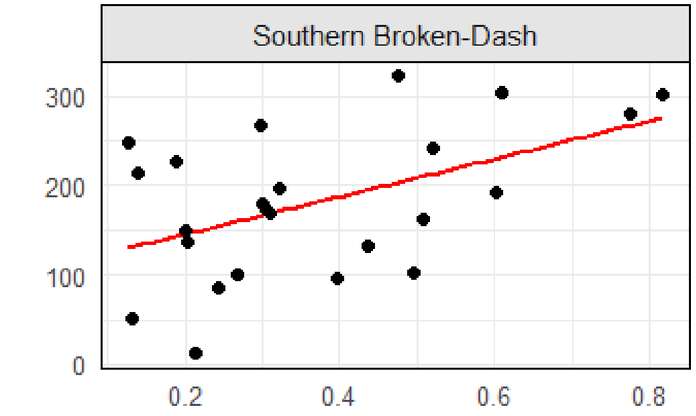


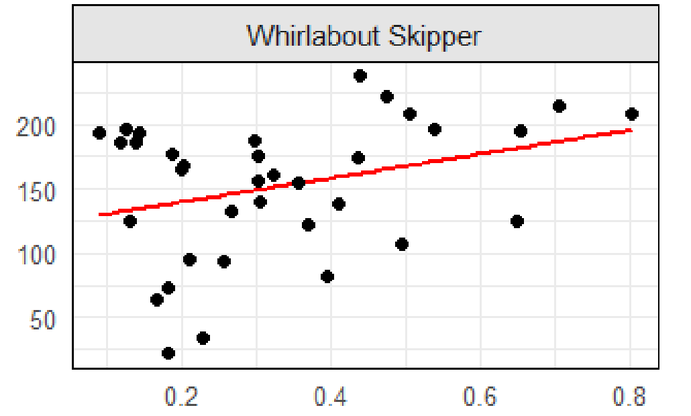


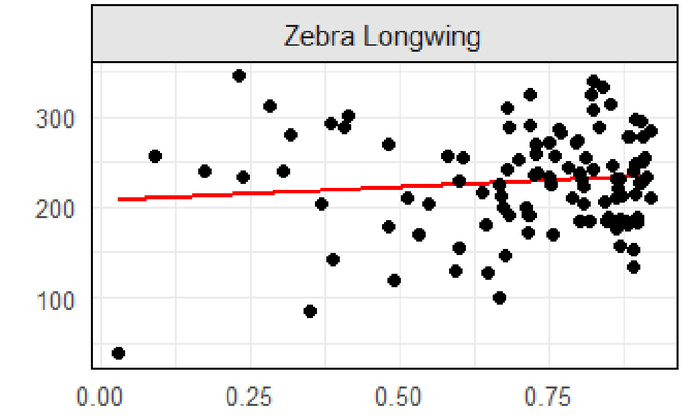












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Preliminary Conclusions, Next Steps

- The flight period of some insect pollinator species is significantly predicted by the level of anthropogenic modification
- Phenological response to anthropogenic modification varies by species
- Future investigations: how this varies by functional group (specialist versus generalist) and morphological traits (e.g., body size)

Questions?

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