Local and Landscape Effects on Butterfly Abundance in CP-42 Plantings

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Local and Landscape Effects on Butterfly Abundance in CP-42 Plantings

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Introduction & Research Questions

Increased conversion of native prairies to crop land have led to a decline in pollinator abundance and an alteration of the pollinator ecosystem. In an effort to counteract this decline, the United States Department of Agriculture’s Farm Service Agency (FSA) developed the Conservation Reserve Program (CRP). CRP offers incentives to farmers to temporarily retire their cropland and restore native prairie vegetation, including pollinator habitat under the CP-42 conservation practice (Hellerstein 124). CP-42 sites must include at least 9 pollinator-friendly flowering plants with a minimum of 3 plants blooming during each of three seasonal periods (USDA 2011). We assessed vegetation, butterfly, and landscape characteristics of 30 central Iowa CP-42 plantings to answer the following research questions:

1) Are there correlations between local (floral abundance or floral diversity) and/or landscape variables (% forest, grassland, wetland, and cropland) and the abundance of butterflies in CP-42 plantings?
2) Do local or landscape variables better explain variation in butterfly abundance in CP-42 plantings?

Methods

Floral resource surveys: In July 2018 & 2019, we surveyed 30 CP-42 field sites within a 60-mile radius of the University of Northern Iowa. In each site, four 100 m transects were established using random point generators in ArcGIS. Floral resources in bloom were then recorded during the first 50 m of the transects by placing a 1 m² quadrat randomly on either the left or right side every 2 m. Pollinator surveys: Pollinator surveys took place between 9 AM and 5 PM on days with temperatures above 10°F and mostly clear skies. Butterflies were recorded visually along four 50 m transects while walking approximately 10 m/min.

GIS Analysis: ArcGIS was used to determine land use around all CP-42 sites surveyed. Polygons for each site were created using ArcGIS, and a 1 km buffer, clipped to exclude the site itself, was established around each site. *High Resolution Land Cover of Iowa in 2009* was then extracted into the buffer layer and the attribute table was used to calculate the percentages of four land cover types (forest, grassland, wetland, and cropland).

AIC Analysis: We modeled total butterfly and Monarch butterfly abundance as functions of two local variables (flower density and floral diversity) and four landscape variables (% forest, % grassland, % cropland, % wetland). After fitting the global model with all potential predictors, we used step-wise AIC analysis to determine the most parsimonious models and to identify which combination of local and landscape habitat variables were most influential in explaining variation in butterfly abundance. Analyses were conducted using the MASS package in R (version 3.4.0).

Results

Candidate Landscape Variables

![Cropland Cover Effects on Butterfly Abundance](image1)

![Grassland Cover Effects on Butterfly Abundance](image2)

![Wetland Cover Effects on Butterfly Abundance](image3)

![Amount Forest Cover Effects on Butterfly Abundance](image4)

Candidate Local Variables

![Butterfly Abundance Effects on Butterfly Abundance](image5)

![Monarch Abundance Effects on Butterfly Abundance](image6)

Butterfly Model Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient Estimate</th>
<th>p-value</th>
<th>Coefficient Estimate</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floral diversity</td>
<td>7.08</td>
<td>0.064</td>
<td>3.04</td>
<td>0.043*</td>
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<td>Grass cover</td>
<td>-0.54</td>
<td>0.087</td>
<td>-0.24</td>
<td>0.059</td>
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<tr>
<td>Crop cover</td>
<td>-0.25</td>
<td>0.129</td>
<td>-0.12</td>
<td>0.026*</td>
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<tr>
<td>Wetland cover</td>
<td>-2.36</td>
<td>0.153</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Global Model (all candidate variables):

Butterfly Abundance = Floral Density + Floral Diversity + Grassland Cover + Forest Cover + Wetland Cover + Cropland Cover

Final Model:

- Floral Diversity + Grass Cover + Wetland + Crop Cover

Monarch Abundance

Global Model (all candidate variables):

Monarch Abundance = Floral Density + Floral Diversity + Grassland Cover + Forest Cover + Wetland Cover + Cropland Cover

Final Model:

- Floral Diversity + Grass Cover + Crop Cover

Preliminary Conclusions

- We recorded 490 butterflies of 16 species in CP-42 fields in 2018-2019. The monarch butterfly (Danaus plexippus) was the most abundant species, accounting for 35% of all butterfly observations and present at 28 of 30 sites.
- Both local and landscape variables influenced butterfly abundance.
- Among all local and landscape factors, floral diversity was the strongest predictor of total butterfly and monarch butterfly abundance.
- Among landscape variables, cropland cover had a significant negative effect on monarch butterfly abundance.
- Grassland cover (total butterfly and monarch models) and wetland (total butterfly only) were included in the best models and had negative effects on butterfly abundance.
- Floral density and forest cover had positive but non-significant relationships with butterfly abundance and were not included in the best-fitting models.

Discussion and Future Research

- Floral diversity is the most important factor in determining butterfly abundance at a CP-42 field.
- Grassland cover had a negative effect on butterfly abundance:
  - As grass is a main component of CP-42 plantings, more research needs to be conducted to determine the cause of this negative correlation.
- Future research:
  - Analyze the different species of grass on ArcGis to determine if species composition alone affects butterfly abundance.

Acknowledgements

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References


