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Summary

Global population is growing ~ 1.1% per annum with projected populations reaching 9.6-12.3 billion by 2100. Extreme poverty has declined globally by more than half falling from 1.9 billion in 1990 to 836 million in 2015. Increased agricultural production of food, fuel and fiber will be necessary to meet the needs of the growing population. Goals to increase agricultural production are often in competition with other societal goals. Water used to increase food production leads to reduced availability for other purposes, including human consumption. Clearing forested land for use in growing agricultural products decreases biodiversity and carbon sequestration. The difficult and critically important challenge is to balance the multiple needs of society in the most sustainable way possible.

This thesis concentrates on how common vegetation management impacts invertebrate biodiversity, as a critical resource, in an area which is used for intensive agricultural production.

We focused on answering the following questions:

1) **How does mowing regime of agricultural roadsides impact invertebrate assemblages?**

2) **How does extreme earth-moving impact the invertebrate community in a newly created prairie restoration?**

3) **How does a mid-summer wildfire impact a grassland invertebrate community?**

4) **How do the invertebrate assemblages in agricultural fields and edges relate to local and landscape complexity?**

5) **How does the invertebrate population relate to food availability, particularly for birds during the breeding season?**

In chapter 1, I introduce general background information, terminology, and ecological theory. I provide an overview of agriculture in the United States and Europe. I also discuss the research questions and design.

In chapter 2 we looked at roadside edges as an important part of the rural landscape that have the potential to contribute habitat for enhancing biodiversity. Roadside edges are generally managed with a variety of mowing regimes based on non-ecological objectives such as traffic safety, expense and aesthetic perceptions. We conducted a pilot study in rural Sangamon County, Illinois USA to compare the influence of roadside management regime on biodiversity along a roadside with neighboring fields planted in no-till agriculture or Conservation Reserve Program (CRP). Three mowing regimes were applied to a roadside. Two of the management regimes are common in Illinois: mowing twice a year and regular mowing throughout the growing season, both leaving the clippings where they fall. The third regime was regular mowing and removing the clippings. Our study showed invertebrate richness was greatest in roadsides with regular mowing and clippings removed. When invertebrates were grouped as predators, parasites and parasitoids, omnivores, herbivores, flower visitors and detritivores, taxonomic richness remained highest in the area mowed with clippings removed, but abundance varied according to life history requirements of the invertebrates. Taxonomic diversity was not different between treatments.

In chapter 3 we took the opportunity offered by a restoration project associated with a large-scale housing development in central Illinois to survey invertebrates in three phases of plant restoration that were part of a larger project. This cross-sectional study of invertebrate recovery at two, four and five year's post-restoration showed that there was no overall difference in invertebrate taxa richness and diversity. Overall abundance was greatest in the most recently restored area. Richness, diversity and abundance of six functional groups did not differ. The restoration phases of our study were apparently all characterized by early pioneer assemblages that did not differ significantly from each other. The conclusion is that development to more diverse and richer assemblages might take more than five years in some prairie restoration projects. The new and unexpected finding was that the reestablishment of invertebrate assemblages was not closely tied to vegetation restoration.

In chapter 4 we looked at the impact of an accidental wildfire in a 20 ha grassland restoration. New growth provided effective substrate for the noctuid species corn earworm (*Helicoverpa zea* Boddie 1850) and tobacco budworm (*Heliothis virescens* Fabricius 1777). These agricultural pests feed on a number of important crop species and have been implicated in crop losses up to 50 %. Invertebrate collections were made at 16, 45, 70, and 101 days post fire. A comparison of burned and unburned areas at 70 days post fire show 18 times the number of Lepidoptera larvae collected in pitfall traps in the burned area compared to the adjacent unburned area of the grasslands. These findings demonstrate that a mid-summer fire can affect the abundance of economically important insects.

In chapter 5 we continued our study of the acute and chronic impacts of an accidental wildfire on invertebrate populations in a 20 ha grassland restoration in central Illinois, USA. Samples were collected in the burned and nearby unburned areas using sticky boards and pitfall traps each month of the growing season immediately following the fire and the first and third growing seasons post-fire. Our study found that in the third growing season post-fire, some taxa did still not have the same taxonomic richness, diversity and abundance as the neighboring unburned area. Summarizing measures of taxonomic richness, diversity and abundance did not represent the changes in invertebrate assemblages that occurred three growing seasons post-fire. This has implications for fire management decisions.

A better understanding of the factors influencing invertebrate taxonomic richness and diversity at both local and landscape scales is important for conserving biodiversity within the agricultural landscape. The aim of the study described in chapter 6 was to determine if invertebrate richness and diversity in agricultural field interiors and edges in central Illinois, USA, were related to the complexity of the surrounding landscape. Our results show taxonomic richness and diversity in field edges is positively related to large scale landscape complexity, but the relationship is negative for field interiors. These unexpected results need further study.

In chapter 7 we related the structural complexity at local and landscape levels of scale to invertebrate biomass and diversity as a food source. We looked at linear non-crop elements in agricultural areas as an opportunity to provide food for nestlings of avian species. We measured invertebrate availability as it relates to structural complexity at the local and landscape levels in three counties in central Illinois. Invertebrate availability was measured with estimated biomass and taxonomic diversity during spring of 2012 and 2013. Our study shows that field edge characteristics have the greatest impact on invertebrate biomass and diversity, as compared to field and landscape features. This finding shows that the availability of bird food, both in biomass and diversity, may be easily enhanced without changes to agricultural practices.

Finally, chapter 8 presents an overview of the most important results and discusses them in the context of ecological theory, management implications, and recommendations.