Use of roadside prairie plantings by native bees

Do bees avoid roads during their daily commute and other questions

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Introduction

Animal pollinators are integral to the life history of many flowering plants and provide essential pollination in both natural plant communities and agricultural ecosystems. Bees (Hymenoptera: Apiformes) are considered to be the most significant group of pollinators, and are important in the maintenance of diversity in wild flowers (Kearns et al., 1998) as well as the reproduction of numerous agricultural crop species (Delaplane and Meyer, 2000). Wild, unmanaged bees contribute nearly $3.07 billion a year in U.S. fruit and vegetable pollination (Losey and Vaughan, 2006). Alarmingly, losses of wild bees have been documented in some regions of the world (Williams, 1982; Biesmeijer *et al*., 2006), with declines suspected elsewhere (National Research Council, 2007). Threats to bee communities include habitat loss and overuse of pesticides, and such threats may affect not only the bees themselves but also native plant communities and agricultural productivity. Changes in pollinator abundances affect plant reproduction and gene flow (Bawa, 1990) and recent experimental evidence directly demonstrates that plant communities could be negatively affected by a loss of pollinator diversity (Fontaine et al., 2006). Thus, interest in promoting pollinator habitat has increased with concerns of a global decline in pollinators.

Bee habitat must include floral resources as well as nesting substrates. Bees of both sexes may exploit many floral species for nectar, and female bees require pollen for egg production and as food for their offspring (Linsley, 1958). The nesting preferences of bees are highly variable. Many species dig subterranean nests in their preferred location and soil type, while some species nest above ground in plant stems or dead wood (Linsley, 1958). Bumble bees seem to prefer living under clumps of grass or in old rodent nests.

In highly human-impacted environments, marginal habitats (such as hedgerows, roadsides, power line strips and crop margins) become important for the conservation of biodiversity. Roadsides planted with native prairie vegetation may provide particularly valuable habitat to bees (Hopwood, 2008). Roadsides restored to native prairie support plants that provide bees with pollen and nectar, and unlike agricultural fields, are more or less undisturbed nesting sites. Although it has been demonstrated that marginal habitat such as roadsides have potential conservation value to bees, there is a paucity of studies concerning the movement of bees within marginal habitats as well as between patches of habitat. In Iowa, where less than 0.1% of prairie habitat remains (Herzberg and Pearson, 2001) and resources for bees are highly fragmented, understanding how bees use and move through enhanced marginal habitat such as roadside plantings is essential.

Objectives

Several possible effects of roadsides on wildlife have been suggested: roadsides may act as corridors, they attract wildlife but the roads themselves may act as barriers to dispersal or movement, or they may act as supplementary patches of habitat. Corridors are important for maintaining gene flow between populations, increasing population size, and aid in

colonization of new habitats. Roadsides with native vegetation may be valuable stepping stones for pollinators and may provide connectivity to larger resource patches. Roads act as barriers for some wildlife, but little is known about how roads might affect pollinator movement (Bhattacharya et al., 2003). It is important to assess the ability of bees to cross roads successfully, especially when bees may be crossing roads to reach floral resources growing in prairie roadsides. Small patches of semi-natural habitat like roadsides may help maintain pollinator populations, but how bee communities in such fragments affect or are affected by larger habitat fragments like a prairie remnant is understudied. The degree to which bees reside in roadsides is also unknown; bees definitely forage on roadsides but might not nest there. Answering such questions would provide additional insight to the conservation value of roadside plantings to native bees.

The overall goal of this study is to better understand how bees utilize roadsides with prairie plantings, in order to better asses the benefits such roadsides may provide. The three specific objectives are to 1) to determine if bumble bees are moving in roadside prairie plantings as in a corridor, 2) to see if bees will readily and safely cross over roads to reach other prairie plantings and 3) to assess how readily bees move between roadside plantings and other available habitat.

Methods

Study location and study organisms

Six roadsides in central Iowa that have been planted with prairie vegetation and have abundant forbs will be selected with the help of IDOT, ideally three roadsides along four-lane roads and three along two-lane roads. Four of the six roadside sites will be selected due to their proximity (within 4-5 km) to additional natural habitat nearby (prairie, savanna, CRP planting, wetland).

Investigating the movement of bumble bee species will be the primary focus of this study. Bumble bees, in the genus *Bombus*, are native bees that are important pollinators of many floral species, including some prairie forbs. They are large in size (11-25 mm), considerably larger than the introduced honey bee and most other native bee species, and their large body sizes allow them to be strong fliers able to travel long distances (Walther-Hellwig and Frankel, 2000). Bumble bees are extremely hairy with distinct color patterns and can be readily identified in the field (many other bee species are cryptic and require identification via a microscope). Bumble bees are eusocial, meaning that they live in cooperative colonies in which there is division of labor and overlapping of generations (Michener, 2000). Eusocial bee species therefore occur in greater numbers than solitary bee species. Additionally, bumble bees have been found to nest in artificial nest boxes. By placing nest boxes in roadsides, it can be determined if bumble bees are using roadsides for nesting as well as for foraging. The biology of these important pollinators makes them ideal for answering questions about movement within landscapes. Additionally, a possible decline in some *Bombus* species has been suggested (Grixti et al., 2009), making it imperative that we learn more about how they travel within fragmented habitats.

Experiments using mark and recapture of bees

The mark and recapture method is commonly used to estimate population sizes and will here be employed to estimate movement of bumble bees as well as population sizes.

Individuals of the study organism are trapped at a particular location, are marked with a unique tag and are released unharmed back into the area. Allowing a certain amount of time to pass to allow individuals to disperse into the larger population, the area is then re-sampled. Some individuals that were marked in the initial sample will be recollected, others will be collected for the first time, but the capture date of each individual is recorded during multiple resampling.

In order to test whether bumble bees are using roadside plantings as a corridor, five linear 5x40m plots will be established in each of the roadsides. The plots will be spaced apart as in Figure 1. Bumble bees will be captured off of flowers in the center plots (primary plots, see Figure 1) once in June and once in July. Bees will be cooled to make them passive and then will be marked with bee tags (numbered, colored plastic tags glued to the thorax). The time, flower being used, caste (queen, worker, male) and species of each bee will be recorded upon capture. Marked bees will be released in primary plots within 10-20 minutes of initial capture. Half an hour after release, each of the secondary and tertiary plots at a roadside site will be surveyed for marked bees simultaneously by different observers for two hours, and plots will continued to be surveyed for marked bees for three subsequent days over a one-two week period (as weather allows). All mark and recapture data will be analyzed using MARK software.

To determine if bees are willing to cross roads to forage between roadside prairie plantings, a 5x200m plot will be established in the roadside opposite the primary plot. Marked bumble bees will be surveyed for two hours on three days over a one-two week period, concurrently with the corridor surveys. Number of bees recaptured on the other side of the road will be compared with the frequency predicted if the road were no barrier (as in Munguira and Thomas, 1992).

Four of the roadside sites will be located within several kilometers of a patch of natural or semi-natural habitat attractive to bees (prairie reconstruction or remnant, savanna, wetland, CRP planting, organic farm with field margins). In each patch a 5x200m plot will be established, and bumble bees will be marked and released in each of the four proximate habitats. Bumble bees will then be surveyed for two hours on three days over a one-two week period. Bumble bee species richness and abundance of proximate habitat will be compared to richness and abundance of nearby roadside plantings using paired t-tests.

Each site (roadsides, opposite roadsides and proximate habitat) will also be surveyed for floral resource availability, once in June and once in July. Floral diversity and abundance will be measured by determining the percent cover of forbs and by counting the floral species inside a 1x1m quadrat that will be tossed randomly within the 5x40m corridor plots six times each, and 30 times within each 5x200m continuous plot. Weather data such as wind speed, relative humidity, cloud cover and temperature will be recorded at each site. Bees will only be surveyed on calm, warm, sunny days with 60% or less cloud cover. Voucher specimens of each bee species observed will be collected from experiments in both June and July and may be later deposited in Iowa State University's Insect Collection.

Are bees nesting in roadside plantings?

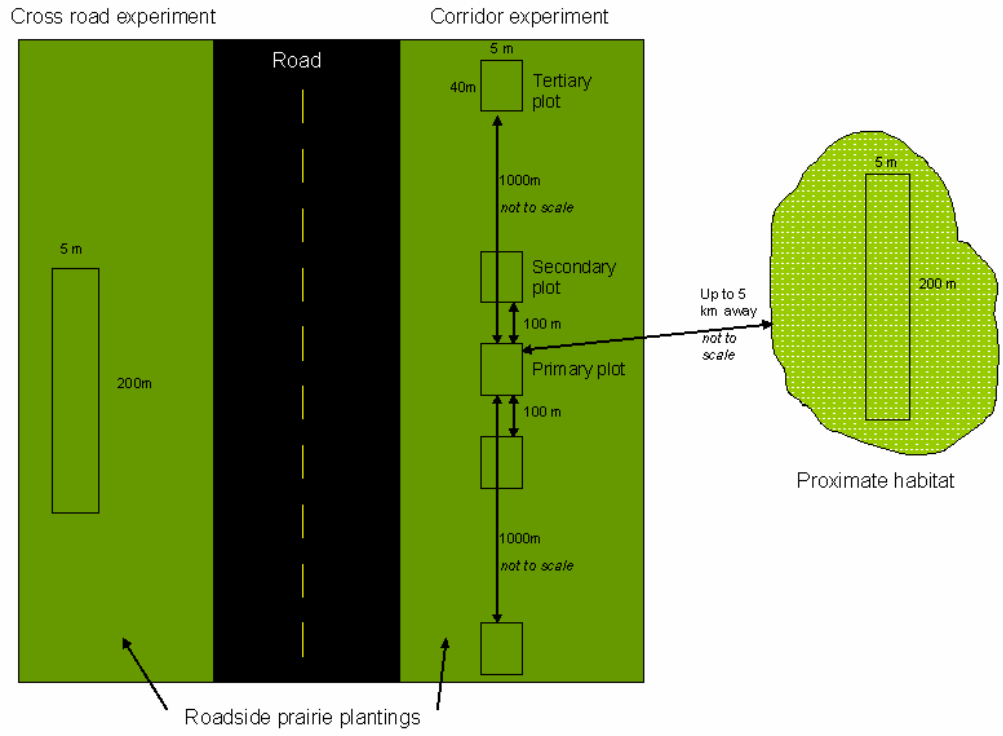
Artificial bumble bee nests will be placed on roadsides, to see if bees are willing to nest in roadside habitat. At each roadside site, four nests will be placed near the ground approximately 50m apart. Signs will be posted near each nest to notify roadside managers and citizens of potential nesting locations. Nests will be put out in late March or early April,

when queen bees emerge from winter's diapause and seek out new locations for their own nest. The rate of occupancy of the artificial nests will be determined mid-summer. The nests will be removed from roadsides (diapausing bees will be transferred to other habitat) in late fall to accommodate roadside management.

Significance of proposed work

The goal of this study is to further examine the value that restored roadsides may have to native bees. By investigating whether bumble bees are nesting in the roadsides, moving in roadside plantings as they might in a corridor, determining the rate of bees crossing roads, and the movement of bees between roadside habitat and proximate habitat in surrounding landscape, this study will provide further insight into how bees utilize roadside prairie plantings. Such questions are crucial for understanding how pollinators persist in highly modified and fragmented landscapes. An additional outcome will be a taxonomic list of bumble bees found on roadside habitats and knowledge of their geographical distributions, useful side benefits given the possible decline of Midwestern *Bombus* species. A list of plants that attract bumble bees will also be generated. This project will involve students from Iowa community colleges or universities. The findings will be presented at a national meeting (North American Prairie Conference or similar conference), and will be submitted for publication in a relevant journal (Biological Conservation or similar journal). This study will improve understanding of how bees move within fragmented landscapes, a valuable contribution that could be applied to conservation efforts in the future. Traditionally, conservation efforts have been directed towards large vertebrates and their habitats. Although there is an increasing awareness of threats to invertebrates and concern over the loss of invertebrate diversity, studies are needed to determine how invertebrate populations, particularly pollinator populations, can be sustained in primarily agricultural landscapes.

Figure 1.



Timeline

Fall 2009- January 2010:	An "Application to Perform Work within State Highway Right-of-Way" will be submitted to IDOT to gain permission for bee monitoring on roadsides.
March/April 2010:	Artificial bumble bee nests will be placed at roadside sites.
June 2010:	First round of experiments: bees will be collected, marked, and recollected at roadside locations and nearby habitat. Floral diversity and abundance measurements will be taken.
July 2010:	Second round of experiments: bees will be collected, marked, and recollected at roadside locations and nearby habitat. Floral diversity and abundance measurements will be taken. Rate of occupancy of artificial nests will be determined.
Fall-winter 2010:	Data will be analyzed and presented at a national meeting. A final report will be submitted to the LRTF, and a manuscript will be prepared.

Budget

Direct costs:	
Principle Investigator salary:	$2,500
Undergraduate student salary (~144 hrs per student (4) at $11/hr):	$6,336
Undergraduate student benefits (at 7.65%):	$485
Travel (mileage to sites, presentations at meetings):	$1000
Supplies and Equipment:	$622
Two aerial nets (at $20 each) = $40 Bee tags ($25.50 for 100) = $102 Artificial nest supplies (~$20 per box) = $480	
Total Direct Costs:	$10,943
Indirect Costs (8%):	$876
Total Request:	**$11,819**

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