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Research Paper

Use of cover crop fields by migratory and resident birds

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ABSTRACT

Cover crops, established between the growing seasons of primary crops to improve soil and water quality, have become increasingly popular in the Midwest region of the United States; however, the impact on migratory and resident birds is largely unknown. We conducted avian surveys on four field types in east central Illinois in the spring of 2015 and 2016: maize (*Zea mays* L.) stubble with cover crop, maize stubble only, soybean [*Glycine max* (L.) Merr.] stubble with cover crop, and soybean stubble only. For each field type, we calculated relative bird abundance and the Avian Conservation Significance value (ACS). Relative bird abundance was greater in cover crop fields than non-cover crop fields, with the maize fields planted with cover crops providing the greatest value (nearly twice the number of individuals and twice the species compared with non-cover crop soybean fields). The most common species were Red-winged Blackbird (*Agelaius phoeniceus*), Common Grackle (*Quiscalus quiscula*), and American Robin (*Turdus migratorius*). ACS values were most influenced by the Eastern Meadowlark (*Sturnella magna*), a species of high conservation concern. Many agricultural landscapes lack habitat in the spring and cover crop fields may be important areas to provide shelter and forage for birds. While we documented greater use of these fields more research is needed to understand why birds use these fields; more explicitly are birds finding cover, foraging, or attempting to breed in cover crop fields? As the amount of cover crop area increases, the value of these fields for migratory and resident bird use may increase. While habitat for wildlife is a secondary consideration when planting cover crops, my research suggests the use of cereal rye and later termination of cover crops benefits birds. Cover crops will not replace natural habitats for birds, but the widespread use of cover crops may benefit some bird populations.

1. Introduction

Modernization of agricultural practices has led to dramatic changes in the landscape. Today, less than 1% of the historical 24.2 million hectares of grassland in the Corn Belt states of Iowa, Illinois, and Indiana remain (Samson and Knopf, 1994). As a consequence of this habitat loss, many species have experienced drastic population declines across taxa, such as mammals and amphibians (Mankin and Warner, 1999; Stuart et al., 2004). Also, many breeding bird populations that reside in agricultural landscapes have exhibited long-term declines (Herkert, 1995; Walk et al., 2010; Warner, 1994). Additionally, many migratory birds that pass through similar landscapes during migration are declining (Brown et al., 2001; Skagen, 2006; Stodola et al., 2014). In these landscapes where agriculture is the predominant land cover, effective conservation of wildlife will only be accomplished by implementing agricultural practices that benefit wildlife populations.

Few agricultural practices exist that truly benefit wildlife species (but see Shengfa and Xiubin, 2017 for a review pertaining to Europe) and the ones that have been shown to be beneficial are those that try to replicate or emulate more natural habitat. They emulate more natural habitats through changes in tillage practices or through the addition of non-tillable ground that provides more suitable habitat for foraging and nesting. No-till fields for example, where the ground is not tilled post-harvest and the next crop is planted directly into the previous crops' stubble, support more bird species, greater nest density, and greater nest success than tilled fields for songbirds and waterfowl (Basore et al., 1986; Duebbert and Kantrud, 1987; Higgins, 1977; VanBeek et al., 2014). Presumably because these fields offer some areas for safe nesting and roosting in comparison to traditional practices. Even reduced or minimum tillage, where grain stubble is left standing until spring then plowed, can increase bird abundance and the number of productive territories (Flickinger and Pendleton, 1994; Martin and Forsyth, 2003). Aside from changes in tillage practices, adding additional habitat can be beneficial, For example, grass waterways, which are channels that transport water off fields, have been shown to support greater abundance of birds and species richness compared to surrounding fields

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(Bryan and Best, 1994; Fiener and Auerswald, 2003). A popular and growing agricultural practice that could potentially benefit bird populations throughout their annual cycle are cover crops, because the practice may create safe resting and roosting sites, increase insect abundance, and/or provide more suitable nesting habitat.

A cover crop is a plant sown into a field to slow erosion, improve nutrient availability and soil health, increase water availability, and suppress weeds, and control insects and diseases (Creamer et al., 1995; Dabney et al., 2001; Villamil et al., 2006). The type of cover crop used, whether a grass, brassica, or legume, depends on the landowner's management goals. Cereal rye, a grass, scavenges a large amount of excess nitrogen (N), prevents soil erosion, adds organic matter, and suppresses weeds. Crimson clover, a legume, is a source of N, and also prevents soil erosion, and suppresses weeds. An example of a brassica is radish, which reduces soil compaction, in addition to preventing soil erosion, scavenging nutrients, suppressing weeds, and controlling nematodes (SAN, 2007). In North America, cover crops have been heavily promoted recently and incorporated into several state nutrient reduction plans in response to the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force's, 2008Action Plan (2008) and the EPA's guidance memorandum (Stoner, 2011) on water quality issues. A thirty-one percent reduction in nitrate was reported with the use of a rye cover crop (IDALS, 2013), and out of all field practices, cover crops were estimated to reduce the most N, thus making cover crops a vital component in reducing nutrient runoff (IDA and IEPA, 2015). The 2012 Census of Agriculture (USDA NASS, 2012) reported that Illinois, Indiana, and Iowa combined had over 2.8 million acres in cover crops, and the amount of area in cover crops continues to expand (ISDA and IDEM, 2015; IDALS, 2013; SARE, 2016).

Cover crops are often promoted as being beneficial to wildlife; however, there is little evidence on its benefits. Some research suggests that cover crops can be used to control pest insects (Bottenberg et al., 1997; Liang and Huang, 1994; Tillman et al., 2004), provide floral resources for native bees (Ellis and Barbercheck, 2015), and enhance reptile abundance (Carpio et al., 2017), yet the benefits to other wildlife within intensively managed row crops remains poorly understood. The only study linking the benefits of cover crops to birds within row crop agriculture comes from a European study that found more declining farmland bird species in seed bearing cover crops along field edges during the winter months (Stoate et al., 2003). Although two other studies show evidence of cover crops benefiting birds within Mediterranean olive groves (Castro-Caro et al., 2014, 2015), cover crops are utilized in vastly different ways in the Midwest region of the United States than they were in the five previously mentioned studies. In the Midwest, cover crops are planted on whole fields after the main cash crop has been harvested and terminated in early spring before flowering and seeding if they did not die over winter.

Given the current and projected extent of cover crops, we were interested in investigating its potential benefits to wildlife. Specifically, we investigated how various suites of migratory and resident birds used cover crop fields compared to fields without cover crops during spring migration. We also investigated if there was a difference in relative bird abundance between cover crops planted in maize or soybean stubble fields. After determining the relative avian use of cover crop versus non-cover crop fields, we investigated how these fields contributed to supporting bird species of conservation concern during spring migration using Partners in Flight (PIF) conservation concern scores (Carter et al., 2000). Finally, we discuss the overall impact of cover crops on bird communities in agricultural landscapes.

2. Methods

We used sites located in Champaign, McLean, Livingston, and Vermilion counties in central Illinois. We identified farmers using conservation practices and cover crops through local Soil and Water Conservation District (SWCD) and Natural Resources and Conservation Service (NRCS) offices. We selected sites that were in a maize-soy or maize-soy-wheat rotation, practicing minimal tillage or no-till, and located in predominately agricultural landscapes (> 85% cultivated land). Landscape cover type composition was determined by 2014 orthophotographs and United State Department of Agriculture's (USDA) CropScape data layer (USDA NASS, 2014).

Fieldwork was conducted from March through June in 2015 and 2016. Cover crop and non-cover crop fields of maize (*Zea mays* L.) and soybean [*Glycine max* (L.) Merr.] were surveyed, resulting in four combinations: maize stubble only (2015, n = 5; 2016, n = 7; total n = 12), maize stubble with cover crop (2015, n = 10; 2016, n = 18; total n = 28), soybean stubble only (2015, n = 7; 2016, n = 12; n = 19), and soybean stubble with cover crop (2015, n = 5; 2016, n = 11; n = 16). Twenty seven fields were surveyed in 2015 and forty eight in 2016 with 17 of the fields from 2015 being surveyed again in 2016. Average field size was as follows: maize only, 37.4 ha (SD 21.1, range 9.0–76.8); maize with cover crop, 30.2 ha (SD 12.0, range 9.1–64.3); soybean only, 42.8 ha (SD 27.5, range 4.1–122.5); soybean with cover crop, 30.8 ha (SD 17.2, range 15.6–84.7).

Cover crops were planted in the fall either immediately before or after harvest of the main crop by drill or broadcast seeding equipment. The majority of cover crops went dormant in the winter and continued growing in the spring, but a few were winter-killed species (oats, radishes). Cover crops can be classified into three broad categories: grass (cereal rye *Secale cereale*, annual ryegrass *Lolium multiflorum*, winter wheat *Triticum aestivum*, oats *Avena sativa*, sorghum-sundangrass *Sorghum bicolor* × *Sorghum bicolor* var, *Sudanese*), legume (crimson clover *Trifolium incarnatum*, winter pea *Pisum sativum subsp Arvense*, sunn hemp *Crotalaria juncea*), or non-legume broadleaves (penny cress *Thlaspi arvense*, turnip *Brassica rapa*, rapeseed/canola *B. napus*, oilseed radish *Raphanus sativus*). Thirty-five out of the total 44 cover crop fields surveyed used one cover crop, but 9 used multiple plant species, which is commonly referred to as a "cocktail mix." We constructed four groupings from the three cover crop categories: grass (n = 34), non-legume broadleaf (n = 4), grass and non-legume broadleaf (n = 1), and a grass, legume, and non-legume broadleaf combination (n = 5). Within the grass category, cereal rye was the predominant type of cover crop (n = 31). Within the two mixed categories, various combinations of annual rye grass, crimson clover, radish, winter pea, and oats were used. The non-legume broadleaves category consisted of pennycress (n = 1) and a mixture of radish, rapeseed, and turnip (n = 3). All cover crops were terminated with herbicide in the spring at varying times.

2.1. Bird surveys

Bird surveys were conducted from mid-March to mid-May via line transects using auditory and visual detection to identify birds (Buckland et al., 2001). Transects started at the perimeter of a field and the observer walked perpendicular to the perimeter towards the center of a field for approximately 10 min and then angled back to the edge (not the edge where the survey began). This allowed for both the center and edge of field to be surveyed with approximately the same amount of effort. On average, a field was visited four times, with a minimum of one week in between visits, and transects were walked on average for fifteen minutes. Surveys were conducted from sunrise to no later than 1200. Surveys were conducted by a total of three individuals between 2015 and 2016. One individual conducted 70% of the 260 transects, the second individual conducted 16% of transects, and the third individual conducted 4% of transects. To control for potential observer bias, fields surveyed by more than one observer (n = 31) were alternately surveyed. To reduce bias due to environmental variables, transects were not conducted in rain nor when wind speeds were above 24 km/h. Individual fields were sampled at different times in the morning to avoid bias due to time of day. To account for differences in effort, the number of meters walked per transect was recorded using GPS and used to calculate relative bird abundance. We did not include birds flying over fields in analyses.