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Does no-till soybean farming provide any benefits for birds?

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ABSTRACT

Nesting success and avian communities were compared between tilled and no-till soybean fields in Illinois. No-till had greater densities of birds than tilled fields, and the overall community in no-till was of greater conservation value due to more grassland birds using no-till compared with tilled fields. Nesting density was greater in no-till (4.5 nests/100 ha) than in tilled (1.6) fields. The most common nesting species were American robins, vesper sparrows, and mourning doves. Nest success, as estimated from daily survival rates, was 19.4% in no-till and 9.4% in tilled fields. Predation was the main cause of nest failure, but 24.4% of failures were caused by farm machinery. The authors propose that the previous year's crop residue and greater abundance of weedy plants in no-till resulted in increased nesting and foraging activity in no-till and greater nest success because of increased opportunity to conceal nests in no-till compared to tilled fields. No-till provides greater benefits to birds than tilled fields, and the large amount of acreage in row crops dictates that we understand the contribution of no-till fields to grassland bird populations.

1. Introduction

Declines in the diversity and abundance of wildlife have followed intensification of agriculture and homogenization of habitat (Peterjohn and Sauer, 1999; Benton et al., 2003). While these effects have been observed in South America (Schrag et al., 2009) and Europe (Donald et al., 2001), declines of birds in the Midwestern United States have been dramatic due to intensive row cropping (Wooley et al., 1985; Warner, 1994). In particular, declines of grassland birds have largely resulted from conversion of grasslands to row crops (Warner, 1994). Over the last 30 y, grassland birds have experienced one of the most consistent and widespread declines of any other bird group in North America (Sauer et al., 2011). Nonetheless, alternative cropping practices, such as no-till, may offer better prospects for wildlife relative to more intense tillage practices (i.e. conventional tillage) and could provide conservation benefits to birds.

Use of no-till has increased across the United States since the 1980s, with estimated annual increases of 1.5% since 2005 (USDA-ERS, 2010). Up to 50% of soybeans in Illinois are currently planted under no-till with even greater proportions in other Midwestern states (CTIC, 2010). Whereas the primary driver for no-till practices is soil and water conservation and associated economic benefits (Cannell and Hawes, 1994), a secondary benefit may be enhanced wildlife habitat. Bird surveys in Europe have shown that broad scale changes in farming practices, such as enrollment areas for a targeted management practice such as crop stubble, can increase farmland bird populations (Doxa et al., 2010; Baker et al., 2012).

Despite continued increase of no-till, only one study in the past 30 y has explicitly investigated the role of soybean no-till in the nest density and success of birds (Basore et al., 1986); greater nest densities were found in no-till than tilled fields. Several studies have documented greater avian abundance and species richness in no-till compared with tilled corn and soybean fields (Castrale, 1985; Walk et al., 2010a). Studies in other areas of the United States in different crops (ex. wheat, sunflowers, fallow) have also documented benefits of no-till for breeding ducks (Duebbert and Kantrud, 1987) and greater songbird nest densities in minimum tillage and no-till compared with conventionally tilled crops (Lokemoen and Beiser, 1997; Martin and Forsyth, 2003). These studies, however, do not provide daily survival estimates, making comparisons across studies and habitats difficult.

Vegetation diversity and structure likely drive patterns of increased bird and nest density in minimum and no-till fields (Wray and Whitmore, 1979; Castrale, 1985; Flickinger and Pendleton, 1994). Warner et al. (2005) found that "cleaner" agricultural practices, such as intensive weed and shrub management in and around crop fields, have resulted in agricultural areas becoming less appealing for birds, resulting in lower avian diversity and density. Birds could experience reduced nest success if nests are initiated before tillage and planting operations, creating an ecological trap (Best, 1986). In Illinois soybeans tillage operations most often occur

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in the fall, thus eliminating the effect of tillage as the mechanism for an ecological trap in crops and making the mechanical disturbance associated with planting the crop the primary farming operation that could cause nest failure. Given the large acreage of row crops, the potential for no-till practices to be of greater value than traditional approaches, and the potential for soybeans planted via no-till methods to create an ecological trap, there is a pressing need to understand the viability of bird populations under alternative tillage practices (Johnson et al., 2011).

The density and relative conservation value of bird communities, as determined by regional conservation priorities (Carter et al., 2000), were compared between no-till and tilled soybean fields. Differences between nest density and nesting success of birds in tilled and no-till soybean fields were explored. Daily survival rates of nests were estimated and three model sets were evaluated to determine the factors associated with: (1) overall nest survival in soybeans, (2) the role of predator behavior in nest survival, and (3) the role of farming activity in nest survival. The nest survival estimates of this study were compared with studies in grasslands embedded within landscapes dominated by row crops. Finally, how soybeans, particularly no-till fields, may contribute to bird conservation in agricultural landscapes is discussed.

2. Methods

Field work was conducted in soybean fields in two counties (McLean and Champaign) in east-central Illinois from 2011 to 2012. Both areas were dominated by corn (*Zea* sp.) and soybeans (*Glycine* sp.). Twelve fields were sampled each year, six no-till and six tilled, for a total of 24 fields. Average size of no-till fields was 20.9 ha (SD 7.5 ha, range 9.2–32.0 ha) and 18.0 (SD 5.6, range 14.0–32.0) for tilled. Land cover in both areas contained over 85% cultivated land, with less than 5% land cover consisting of forest, wetlands, and grasslands combined (USDA NASS, 2012). Three no-till and three tilled fields were selected in each county, or "region", each year. The landscape surrounding each field was comparable and comprised of similar proportions of tilled and no-till areas.

Soybeans were planted into corn stubble each year regardless of tillage practice. "Tilled" fields were generally under conservation tillage practices; a minimum of 30% residue from the previous crop year was left on the soil surface at the time of planting. Fields were tilled with chisel plows in fall, spring, or both. Tilled fields were often leveled with a cultipacker to smooth the soil surface, but the degree in which this practice was applied varied according to farmer preferences. Any spring tillage activity occurred immediately before a field was planted. "No-till" fields received no tillage, and soybeans were directly drilled into the soil surface between rows of standing corn stubble. Row width of fields varied between 8 cm and 30 cm. In 2011, no-till fields were planted between 10 May and 4 June, and tilled fields were planted between 18 May and 11 June. In 2012, no-till fields were planted between 8 May and 15 May, and tilled fields were planted between 1 May and 25 May. The only farming activities observed after planting were applications of a non-selective glyphosate herbicide.

2.1. Field sampling

Bird densities were estimated on all fields by traversing fixed-width line transects (Buckland et al., 2001). Transects were established in ArcMap (ArcMap for Windows, version 10.0; ESRI, Redlands, California) and overlaid on aerial photos of each field. The number and length of transects per field was based on the size and shape of the field. The number of transects per field ranged from 1 to 3, while the length of transects varied from 250 m to 700 m. Birds that were seen or heard perched within 50 m of transect lines were counted, and the perpendicular distance to the transect was estimated for each bird. Surveys were conducted between sunrise and approximately 10:00 h when songbirds are most active. Six surveys were conducted at all sites each year between 10 May and 10 July.

To determine if the community of birds using no-till was of greater conservation value than that of tilled fields, the avian conservation significance (ACS) value was calculated for no-till and tilled fields (Nuttle et al., 2003; Twedt, 2005), using relative species' density. The ACS value is calculated using Partners in Flight (PIF) conservation concern scores from bird conservation region (BCR) 22, the eastern tallgrass prairie ecoregion (Carter et al., 2000; Panjabi et al., 2012; http://www.rmbo.org/pif/archives/archives.html).

Nest searches were conducted from mid-April to mid-July in the same fields as were censused for birds. Two to four observers, nearly always three observers, systematically searched fields, walking approximately 10 m apart parallel to crop rows until the field was completely traversed. No-till fields were searched on a weekly basis and tilled fields on a bi-weekly basis, but nest searching effort was accounted for in estimates of nest densities. Nests were most often located by flushing incubating females or by observing birds that were carrying nesting material or food for nestlings. Nests of all species were monitored every 1–4 d until they failed or fledged at least one chick. Nest locations were marked with utility flags placed a minimum of 10 m from the nest and georeferenced (Garmin eTrex). Nests were classified as failed or successful by incorporating nest site characteristics such as nest disturbance, fledgling presence, nestling age at the previous visit, and evidence of farming practices (tire tracks, vegetation disturbance). Because we were interested in whether a nest could escape predation and farming induced failure, a nest that only fledged a cowbird ($n = 2$) was considered successful.

2.2. Statistical analysis

Program Distance 6.0 v.2.0 (Thomas et al., 2010) was used to estimate bird densities (birds/ha) for each field type, no-till and tilled. Few detections per species necessitated pooling of species to determine overall detection probabilities and densities. Observations were truncated at 40 m for analysis.

Estimates of nest densities were adjusted for search effort. To account for differential search effort, the average density of nests per 100 ha searched was calculated based on the number of times a field was searched each season; field area was multiplied by the number of searches conducted, and the number of nests was subsequently divided by this number and then multiplied by 100 to get nest density per 100 ha searched. A balanced, two-way ANOVA was used to compare nest densities between no-till and tilled fields, years, and the interaction of these factors. Most nests were found early in their nesting cycle (i.e. laying and incubation stages, 85.9%, 98/114), providing confidence that a high percentage of nests were found. Equal nest detectability was assumed between no-till and tilled fields. Fischer's Exact Test was used to assess whether nests were more likely to be initiated before soybeans had been planted in till vs. no-till fields; 31 May was the date by which 87.5% (21/24) of the study fields and nearly all fields in the area had been planted. Nest initiation dates were estimated with similar methods to that of Cox et al. (2012) except for nests that were found after hatching; nests were randomly assigned an age between the minimum age possible based on incubation length plus the number of days the nest was monitored and the mean nest cycle length.

To estimate nesting success in no-till and tilled fields, daily survival rates (DSR) were derived using the logistic-exposure method in SAS PROC GENMOD (SAS for Windows, version 9.3; SAS Institute, Cary, North Carolina; Shaffer, 2004). The logistic-exposure method uses the number of exposure days (i.e. the number of days a nest