Avian Use of Hedgerows and Adjacent Crops in Central California Agricultural Landscapes

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Introduction

Wildlife conservation in agro-ecosystems is especially challenging due to habitat loss and fragmentation, intensive human land use, and the need to balance conservation goals with agricultural production. Hedgerows are often incorporated into agro-ecosystem conservation planning since they offer disproportionate enhancement of valuable ecosystem goods and services (e.g., air and water quality protection, weed control, soil erosion control, promotion of pollinators and other beneficial insects, and biodiversity) in exchange for minimal reductions in production (Earnshaw 2004, Long and Anderson 2010, Morandin and Kremen 2012). Hedgerows consist of trees, shrubs, perennial grasses, forbs and other species planted in narrow strips along field margins (Long and Anderson 2010), with the use of native species advocated for in recent years (Long and Anderson 2010, Morandin and Kremen 2012).

Hedgerows are an increasingly common conservation measure in heavily transformed agricultural regions of Central California, in part because of their perceived potential to provide critical habitat for numerous avian species that may utilize the small, linear, wooded patches for resting, foraging, wintering and breeding (Hinsley and Bellamy 2000; Earnshaw 2004). However, avian usage of hedgerows in Central California has not been well-studied, and data is lacking in regard to hedgerow effects on avian abundance and diversity and how these effects differ across wintering and breeding seasons. Understanding these effects will be critical to the promotion of hedgerows as agro-ecological conservation measures in Central California and beyond. In addition, the perception that hedgerows may attract undesirable bird species into agricultural fields (Earnshaw 2004) cannot be addressed without quantitative data on avian use of hedgerows and adjacent fields.

In order to address these gaps in knowledge, we conducted a pilot study of avian hedgerow use in Yolo County from 2011-2012. Our objectives were to use a paired study design to quantify 1) hedgerow effects on avian abundance, richness, and diversity in both wintering and breeding seasons relative to unenhanced field margins (control sites); 2) avian use of adjacent crop fields (standardized by crop type) to determine if hedgerows attract avian crop pests; and 3) key habitat characteristics that may be influencing avian use of hedgerows and unenhanced field margins. In this article, we focus primarily on the results of avian analyses while briefly describing vegetation in hedgerow and control sites.

Methods

We selected four hedgerow sites in Yolo County that were similar in age and structure and that were already being used in UC Cooperative Extension research (Fig. 1). Nearby unenhanced field margins served as control sites, and both hedgerow and control sites were standardized by adjacent crop type. Six 20-min avian search censuses were conducted at 2-week intervals along 0.25-mi stretches of hedgerow and control habitat in both winter (Nov. 2011-Jan 2012) and breeding (Apr-June 2012) seasons. Vegetation surveys were conducted in May 2012, and consisted of identification and measurements of all trees and shrubs (hedgerows) and 1-m^2 percent cover quadrats in understories of both hedgerow and control sites. Statistical comparisons of means were conducted using program R, and statistical significance was assessed at the $P \leq 0.05$ level.

Results

Avian abundance, richness, and diversity. Pooled across seasons, we found that avian abundance was more than three times higher in

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Figure 1 A native-planted hedgerow in Yolo County, California. *Photograph courtesy H.M.White.*

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hedgerows (1689 individuals) compared to control sites (514 individuals). This difference in abundance persisted when the data were analyzed separately for wintering ($N_{hedgerows}$ = 1314 individuals and $N_{control}$ = 331 individuals) and breeding seasons ($N_{hedgerows}$ = 375 individuals and $N_{control}$ = 183 individuals).

Similar results were found for species richness. A total of 41 species were detected at hedgerow sites, compared to 22 species at control sites. Pooled across seasons, average avian richness was nearly double in hedgerows (27.50 ± 1.55 spp.) compared to control sites (15.25 ± 0.95 spp.). Analysis by season showed that average avian richness was significantly higher in hedgerows in both wintering (20.00 ± 1.96 spp. in hedgerows, 8.00 ± 0.41 spp. in control sites) and breeding seasons (17.50 ± 1.32 spp. in hedgerows, 9.25 ± 0.25 spp. in control sites).

Results were less clear for species diversity, which we calculated using the Shannon-Wiener index that accounts for species richness and relative abundance. During the breeding season, avian species diversity was significantly higher in hedgerow sites (9.94 ± 1.15) compared to controls sites (5.70 ± 0.82). No other significant differences in diversity between hedgerow and control sites were detected.

Interestingly, our results showed that avian abundance and richness in adjacent crop fields were not significantly different when hedgerows were present, suggesting that hedgerows are not attracting avian pest species into nearby crops. For example, for three of the most common avian crop pests (American crow [*Corvus brachyrhynchos*], red-winged blackbird [*Agelaius phoeniceus*], and Brewer's blackbird [*Euphagus cyanocephalus*]), there were between five and ten times more birds detected during the study in agricultural fields adjacent to unenhanced field margins compared to crop fields adjacent to hedgerows. Analysis of flyover data collected during the study suggested that these species tended to pass over hedgerows entirely and may have been more focused on crop fields as a landscape feature.

Habitat characteristics. Overstory vegetation in hedgerows was dominated by Coyotebush (*Baccharis pularis*), Black elderberry (*Sambucus nigra*), and California coffeeberry (*Frangula californica*). Mean abundance, richness, and diversity of trees and shrubs in hedgerows were 83 ± 6.50 individuals, 9.25 ± 0.58 spp., and 5.17 ± 0.63 respectively. Understory vegetation in both hedgerows and control sites was characterized by both native and exotic grasses and forbs, although native cover was significantly higher in hedgerows (30.65 ± 8.36%) versus control sites (8.05 ± 3.17%) and exotic cover was significantly higher in control sites (64.90 ± 3.42%) versus hedgerow sites (47.90 ± 6.29%). Hedgerow sites also had significantly more litter, while control sites had significantly more bare ground. No differences in native understory species richness were found, but control sites did have significantly more exotic understory species.

Conclusions and future research directions

We found that avian abundance and richness were significantly higher in native hedgerows compared to unenhanced field margins, especially during the wintering season. During the breeding season, avian diversity was higher in hedgerows compared to unenhanced field margins. Our results strongly suggest that native hedgerows in Central California agricultural landscapes may act as both refugia for wintering songbirds and as habitat for breeding songbirds without attracting avian pests into adjacent crop fields. These findings may serve as an incentive for producers to plant hedgerows at field margins, since native-planted hedgerows positively influence a broad suite of valuable ecosystem goods and services in addition to providing wildlife habitat.

The results of this pilot study are being used to scale up research efforts to include a larger set of study sites across the Sacramento Valley in conjunction with native pollinator researchers at UC Berkeley, enabling us to further understand the effects of hedgerows on avian communities in agricultural landscapes.

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