



Effects of agricultural fragmentation on the bird community in sagebrush shrubsteppe



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ABSTRACT

Habitat fragmentation can change the community composition of species in remnant habitat patches. We studied the impacts of fragmentation by agriculture on the bird community in heavily fragmented areas of the sagebrush shrubsteppe in western North America. We examined whether bird communities in sagebrush habitat near orchards and vineyards were different from the community in interior sagebrush habitat, and evaluated whether observed differences could be explained by predator abundance, local vegetation, the presence of the habitat edge, or the proportion of land cover in the surrounding landscape. The bird community near agricultural edges differed from interior habitat: edge habitats had higher species diversity and were dominated by generalist bird species, while Vesper Sparrows, which are sagebrush-associated in this region, were strong indicators of interior habitat. The bird community also differed between orchard edge habitat and vineyard edge habitat, although the difference was small. Edge effects on species composition were associated with differences in the local vegetation, rather than the predator community or the proportion of urban, agricultural, and sagebrush cover on the surrounding landscape. We suggest that differences in the bird community within edge and interior habitat are the result of multiple mechanisms: avoidance of exotic grasses and attraction to high shrub cover in edge habitat, attraction to resources in adjacent habitats, and spill-over of generalist birds from the adjacent agriculture. The results of this study suggest that sagebrush bird conservation areas should be placed away from agricultural development.

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1. Introduction

Fragmentation occurs as habitat conversion for agriculture continues across the globe, increasing the proportion of edge in natural habitats. Edge habitats can differ from interior habitats and are often characterized by distinct biotic communities (Harris, 1988; Sisk et al., 1997). Communities may be particularly distinct in edge habitat adjacent to anthropogenic land uses, such as agriculture, because the edges of these activities usually possess unnaturally sharp gradients of change (Sisk and Battin, 2002; Ries et al., 2004). Species diversity may be higher in edge habitat because of the addition of generalist and invasive species; however specialist species that are more likely to be of conservation concern often show reduced abundance near anthropogenic edges (Ewers and Didham, 2005).

Species may be more or less abundant in edge habitat than in interior habitat for a variety of reasons (Chalfoun et al., 2002; Ries et al., 2004; Ries and Sisk, 2004). First, species may differ in abundance due to altered interspecific interactions in edge habitat, such as competitive exclusion or predator avoidance (Piper and Catterall, 2003; Renfrew et al., 2005). Secondly, the vegetation may differ between edge and interior habitat causing individuals to prefer edge or interior habitat because of species-specific habitat preferences (Kristan et al., 2003; Davis and Brittingham, 2004). Thirdly, organisms can flow, or “spill-over” from one adjacent habitat to another (Ries and Debinski, 2001; Matthysen, 2002; Blitzer et al., 2012). Finally, organisms may be attracted to edge habitat because they require or benefit from access to both types of habitat (Leopold, 1933; Saunders et al., 1991). In addition, the extent to which a landscape is modified can also influence the strength of local scale edge effects (Donovan et al., 1997). Although more than one mechanism is usually responsible for an edge effect on community composition, few studies have assessed the relative importance of multiple potential mechanisms (Ries et al., 2004).

The sagebrush shrubsteppe of the intermountain west of North America is increasingly fragmented by agriculture

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(Noss et al., 1995; Paige and Ritter, 1999; Knick et al., 2003). Some species of birds that nest in sagebrush shrubsteppe are found at lower densities within fragmented landscapes (Knick and Rotenberry, 1995; Vander Haegen et al., 2000; Vander Haegen, 2007), which may be caused by the avoidance of habitat edges that are more common in those fragmented landscapes. Edge responses could be due to a variety of mechanisms, as bird habitat choice in sagebrush shrubsteppe can be influenced by predator distribution (Chalfoun et al., 2002; Welstead et al., 2003; Chalfoun and Martin, 2010) and vegetative characteristics (Paczek and Krannitz, 2004; Harrison and Green, 2010; Earnst and Holmes, 2012).

We examined whether and how the bird community in sagebrush shrubsteppe differs between interior habitat and edge habitat adjacent to two types of agriculture, orchard and vineyard. We then explored whether the edge effect on the bird community could be attributed to local vegetation differences, avoidance of the predator community, the presence of the habitat edge, or the proportion of land cover types in the surrounding landscape.

2. Methods

2.1. Study area

The sagebrush shrubsteppe is considered an endangered ecosystem with many sagebrush associated plants and animals identified as being of conservation concern (Noss et al., 1995; Wisdom et al., 2003). We studied sagebrush shrubsteppe in the Okanagan region of British Columbia, Canada and Washington,

USA (approximately 49°N, 119°W; Fig. 1A). The Okanagan region is at the northern edge of the sagebrush shrubsteppe that covers much of the Great Basin Bird Conservation Region (BCR 9: NABCI, 2000). Sagebrush shrubsteppe in this region is a dry, largely treeless grassland characterized by bunchgrasses and big sagebrush (*Artemisia tridentata*). During our study, mean temperature and monthly precipitation in the Okanagan region during the breeding bird season (May–July) was 17.5°C and 30.3 mm in 2011, and 18.5°C and 49.5 mm in 2012 (Government of Canada, 2015). Land use pressure in the Okanagan is high and approximately 35% of the sagebrush habitat has been converted to other land uses (USA: 38% Dobler et al., 1996; Canada: 33% Iverson et al., 2008). Historically, fruit orchards and cattle grazing were the primary human impacts in the region. Today, the agricultural industry is increasingly dominated by wine production, and habitat conversion for agriculture continues.

2.2. Study sites

We selected study sites in patches of sagebrush shrubsteppe that were adjacent to agriculture, large enough to include interior habitat greater than 400 m from agriculture in all directions, that had similar vegetation across the study site, and where we were able to obtain permission to access the property. In total, 18 study sites were selected (Fig. 1A). At each study site, a pair of 160 m by 100 m study plots was established. Each pair consisted of one plot adjacent to agriculture (edge habitat) and one plot 400–700 m from agriculture or other anthropogenic land types (interior

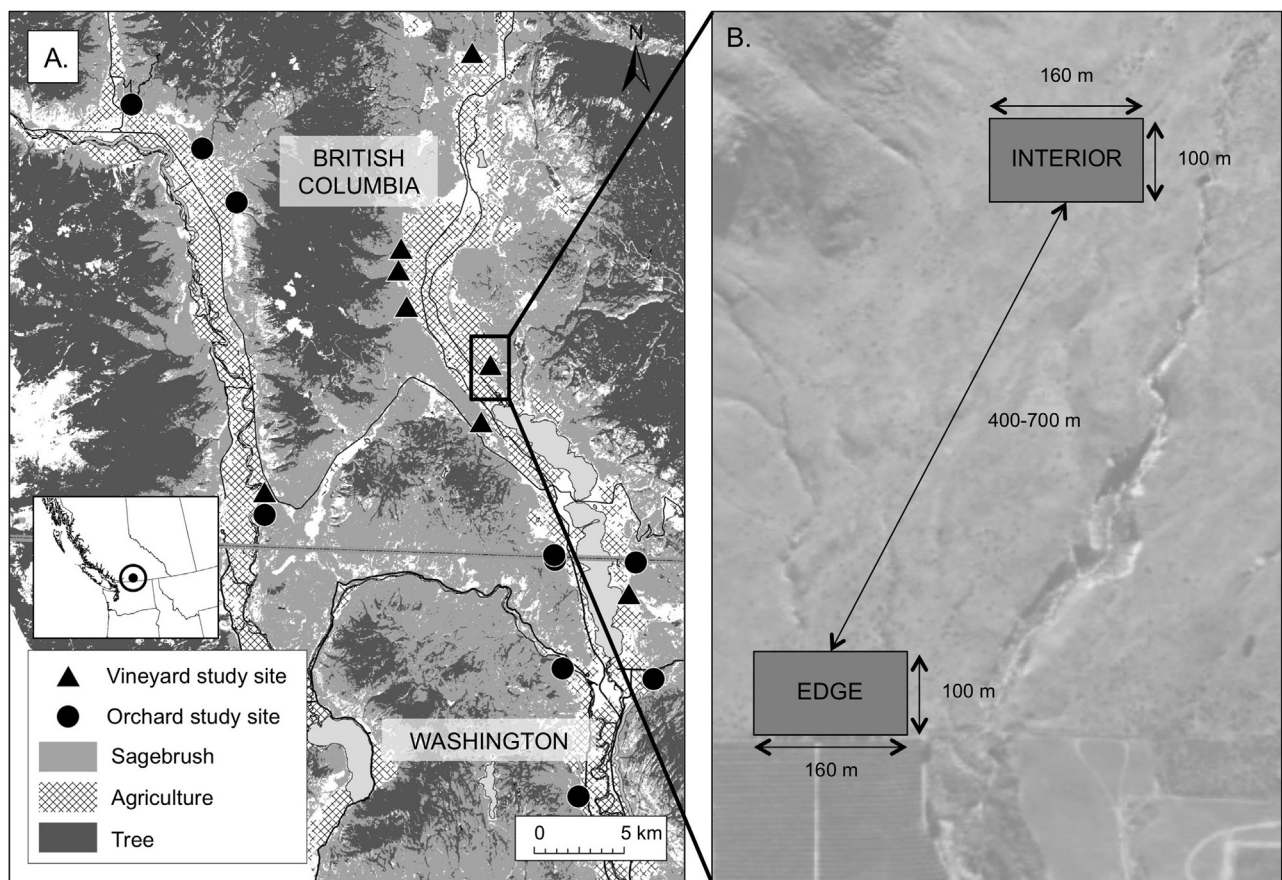


Fig. 1. (A) Sites for studying the bird community in sagebrush shrubsteppe habitat in the Okanagan region of British Columbia, Canada, and Washington, USA (approximately 49°N 119°W). Agricultural land cover is the sum of the orchard, vineyard, and pasture land cover classes. (B) Each study site consisted of a pair of study plots: one plot adjacent to agriculture (edge) and one away from agriculture (interior).

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