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Do landscape features predict the presence of barn owls in a changing agricultural landscape?

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HIGHLIGHTS

- We investigated how changes to the agricultural landscape influences nest site use by barn owls.
- Thirty percent of nest sites used in the early 1990s were lost by 2007.
- Loss of grassland habitat did not predict the continued use of remaining nest sites.
- Barn owls were less likely to persist at sites with increased highway traffic exposure.
- The length of highway within a 1-km radius of available nest sites influences whether they are occupied by barn owls.

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ABSTRACT

Population declines of farmland birds have been linked to the loss and fragmentation of grassland habitats resulting from changes in agricultural practices and urbanization. We investigated how changes to landscape attributes in the Fraser Valley, British Columbia, Canada, influenced the persistence and current occupancy by barn owls at roosting and nesting sites. There has been considerable development in the agricultural landscape of the Fraser Valley between the early 1990's and 2007/2008: grassland cover declined by 53%, the area of urban cover increased by 133%, length of secondary roads increased by 18%, and the volume of highway traffic increased by 33%. We also found that 30% of the sites used by barn owls in the early 1990s have been lost. Although the availability of grasslands are thought to influence the distribution of barn owls, in our study, barn owls were not more likely to persist at sites with little loss of grass cover, or to currently occupy sites surrounded by more grassland. The only variables that predicted the continued use and current occupancy of sites were traffic exposure and the length of highways. Barn owls were most likely to persist at sites with lower increases in traffic exposure and occupied sites containing fewer kilometers of highway within a 1-km radius. We conclude that the distribution of barn owls in the Fraser Valley is influenced by the loss of suitable roosting and nesting sites and location of highways.

1. Introduction

Agricultural landscapes provide important habitat for many plant and animal species. Traditional farming practices such as crop rotations and the maintenance of hedgerow and grassy verges produce a structurally varied landscape capable of maintaining levels of biodiversity similar to that of many natural ecosystems (Bignal & McCracken, 1996; Bohlen & House, 2009). However, changes in agricultural practices over the last 50 years (e.g. use of agrochemicals, modernized machinery) have reduced the heterogeneity of agricultural landscapes, resulting in large, heavily utilized, monoculture fields and an overall reduction in the quality of land as habitat for wildlife.

In addition to changes in agricultural practices, in many areas agricultural land has been lost and fragmented due to urbanization and its associated infrastructure (Forman et al., 2003; Underhill & Angold, 2000). Although urbanization results in habitat loss, infrastructure such as roads and railways can have a disproportionate impact on wildlife due to mortality from collisions with vehicles, restricted access to resources through the barrier effect, or because populations become subdivided and isolated into smaller and more vulnerable fractions (Forman et al., 2003; Jaeger et al., 2005). These changes have been implicated in the declines both in

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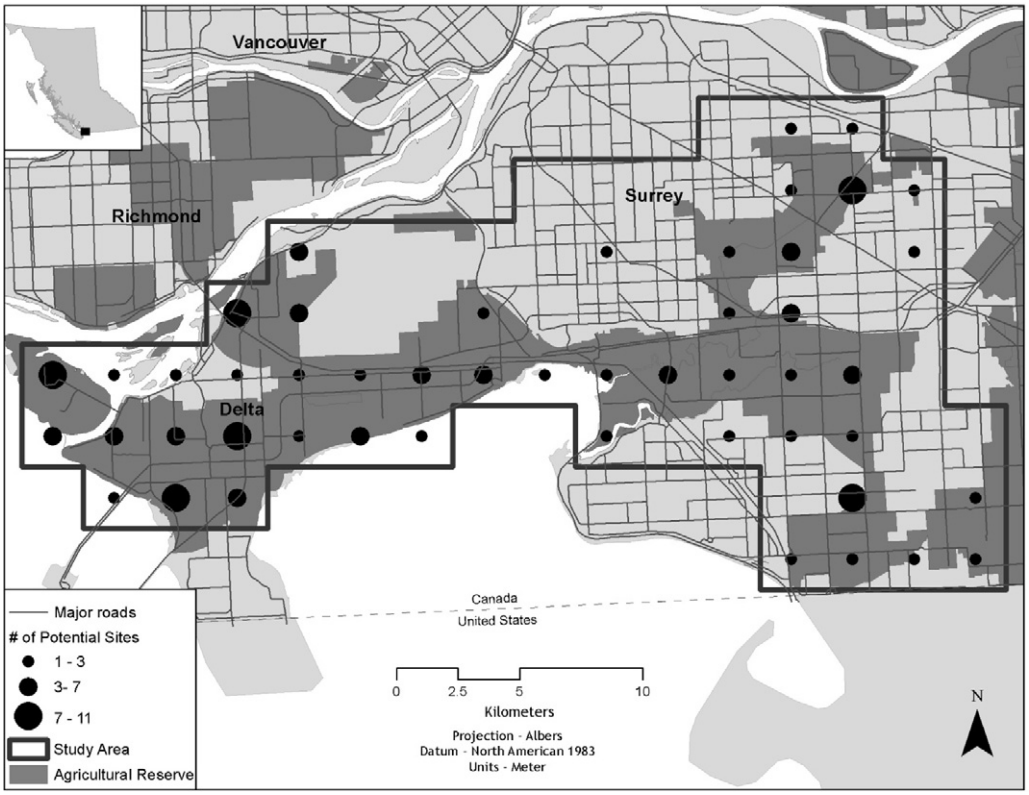

Fig. 1. Study area within the Fraser Valley, British Columbia, Canada used for assessing landscape features that influence nest-site use by barn owls in 2007 and 2008. Exact locations of available nest sites are not indicated because barn owls are a species listed under the Species at Risk Act in Canada and most sites are located on private land.

range and abundance of many species associated with agricultural landscapes (Benton, Vickery, & Wilson, 2003; Filippi-Codaccioni, Devictor, Clobert, & Julliard, 2008; Robinson & Sutherland, 2002).

There is accumulating evidence that farmland birds as a group are particularly sensitive to changes to the agricultural landscape. In Britain, 86% of farmland birds have shown range contractions over the last 40 years (Fuller et al., 1995). Similar trends have been reported from elsewhere in Europe and North America (Brennan & Kuvlesky, 2005; Donald, Sanderson, Burfield, & van Bommel, 2006; Peterjohn, 2003). However, no single factor appears to be responsible for the observed range contractions and population declines (Newton, 2004). For example, population declines in corn bunting (*Miliaria calandra*) and tree sparrow (*Passer montanus*) have been linked to a reduction in winter survival due to loss of fallow grain fields, a key winter food supply (Siriwardena, Robinson, & Crick, 2002; Wilson, Boyle, Jackson, Lowe, & Wilkinson, 2007). In contrast, population declines in lapwing (*Vanellus vanellus*) appear to be linked to higher rates of nest predation resulting from increased grazing intensity on marginal grasslands (Chamberlain & Crick, 2003). The variation in underlying causes for population declines of farmland birds has led some authors to argue that more species-specific research is required in order to design appropriate conservation measures (Fuller et al., 1995; Peterjohn, 2003).

The barn owl (*Tyto alba*) is an iconic farmland bird that has been associated with humans and agriculture for centuries (Bunn, Warburton, & Wilson, 1982). However, barn owls are now experiencing range contractions and declines across their range (Colvin, 1985; Toms, Crick, & Shawyer, 2001). In Britain, where they have been studied most intensively, their numbers are reported to have dropped by 69% over the last 50 years (Toms et al., 2001). Three major factors have been associated with declines in barn owl population. First, the loss of moderate-length grassland over the last 50 years has decreased small mammal populations and potentially prey availability (Colvin, 1985; Taylor, 1994). Second, suitable nest/roosting sites have been lost due to the conversion of old wooden barns into inaccessible steel barns and the removal of old trees as part of field enlargement programs (Ramsden, 1998; Taylor, 1994). Third, adult mortality may have increased due to increases in the number of roads and traffic volume in agricultural areas (Preston & Powers, 2006; Ramsden, 2003).

Population trends for barn owls are not well documented in North America but, based on breeding bird surveys the barn owl is thought to be declining by up to 3% per year in western North America (Environment Canada, 2010). The barn owl population in western Canada was designated as "Threatened" by the Committee on the Status of Endangered Wildlife in Canada in 2010 (COSEWIC, 2010). To evaluate how changes to the agricultural landscape have impacted the distribution of barn owls in Western Canada, we examine how changes in landscape features over the past 15 years have impacted occupancy at historical nest/roost sites, and examine how current landscape features influence the use of suitable nest/roost sites across the Fraser Valley, British Columbia. Specifically we use an information theoretic approach to assess the role of four features of the landscape surrounding available nest sites hypothesized to impact the distribution and breeding of barn owls: (i) the amount of grassland cover (Colvin, 1985; Taylor, 1994), (ii) the fragmentation of grassland habitat (Taylor, 1994), (iii) urban development and (iv) traffic exposure, or length of highways (Bond, Burnside, Metcalfe, Scott, & Blamire, 2005; Lodé, 2000; Ramsden, 2003).