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Associations of Winter Birds with Riparian Condition in the Lower Calapooia Watershed, Oregon

Abstract

We examined the association between winter bird community composition and three riparian vegetation types common in the central Willamette River basin: grass-riparian, shrub-riparian, and forest-riparian. There were 20 times more birds detected and 3 times as many species detected in forest-riparian sites than in grass-riparian sites. There were over three times as many species observed in forest-riparian sites as grass-riparian sites. Not all species were associated with trees or shrubs, and not all that were associated with trees or shrubs were riparian dependent. A significant curvilinear relationship was detected between tree cover and winter bird species richness. Based on this relationship we hypothesize that providing 10-15% of a square km in tree cover would maximize winter bird richness within the range of conditions that we sampled.

Introduction

Riparian areas are one of the most vulnerable ecosystems in the U.S., and agriculture has been considered an important cause of riparian loss (NRC 2002). In the arid West, livestock grazing has been shown to have adverse effects on habitat availability for tree- and shrub-nesting riparian species (Sanders and Edge 1998, Dobkin et al. 1998). In the intensively managed farmlands of the Midwest, habitat for winter and breeding birds in riparian areas has been adversely affected by row-cropping, tillage, drainage, irrigation, and channelization (NRC 2002). Previous work in the Midwest indicates that soil and water conservation practices can have positive effects on the presence and abundance of grassland and shrubland birds. Retaining or re-establishing tree cover along riparian areas (Perkins et al. 2003), providing grassed waterways (Bryan and Best 1991), using no-till practices (Lokomoen and Beiser 1997), retaining fencerows and vegetated roadsides (Best 1983, Camp and Best 1993), and establishing shelterbelts (Yahner 1982), as well as simply leaving fields fallow (Delisle and Savidge 1997) all have been shown to increase habitat availability for some native bird species.

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Intensive row-cropping is not restricted to the Midwest. Over $1 billion dollars of agricultural products are produced from the Willamette River Basin annually (Hulse et al. 2002). In addition, over 65% of Oregon's population occurs in the Basin and an additional 1.7 million people are expected to live in the Basin in the next 50 years. The area has seen huge change in land cover since early settlers arrived in the Basin about 150 years ago (Boag 1992). Upon arrival of settlers in the Basin, about 19% was in native grasslands, 8% in wetlands, and 19% in hardwood forests and shrubs, with the remaining area in conifer and mixed-conifer forests and savannas (Hulse et al. 2002). Today, natural grasslands and wetlands occupy < 1% of the region and agricultural fields, largely grass-seed farms, occupy much of the lowlands in the Basin (Hulse et al. 2002). Whereas riparian protection regulations have been established for forest lands, they are not in place on agricultural lands, and demand for increased production of grass seed has led some farmers to farm to and through small streams in the Valley (Figure 1a). Such practices raise environmental concerns that have been partly addressed by altering farming practices to include finely chopping all residues back onto the fields, no-till direct seeding, grassed waterways, and establishing conservation easements. Nonetheless, the effects of these conservation practices

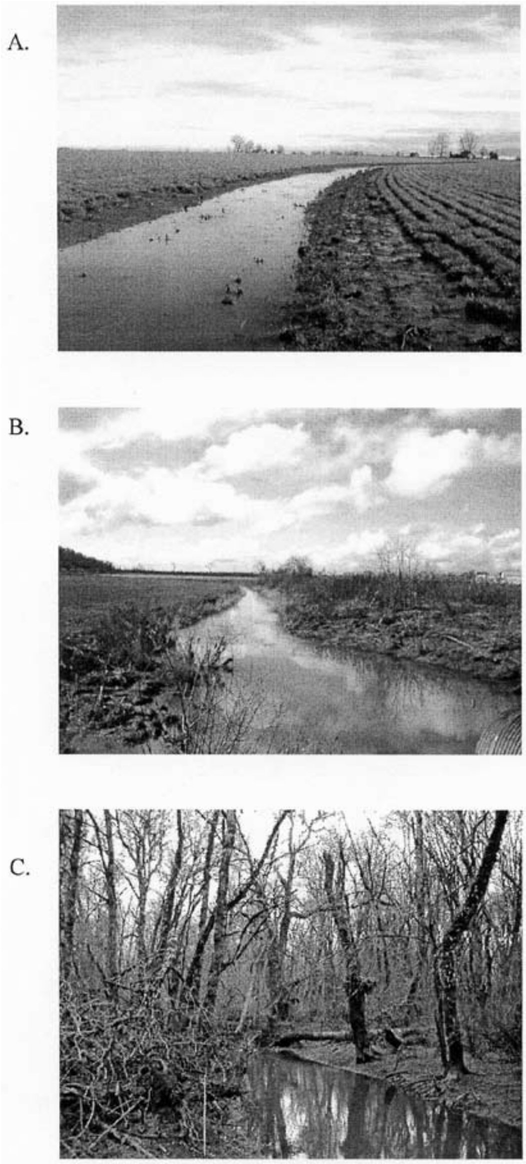

Figure 1. Examples of streams bordered by grass fields (A), shrubs (B), and trees (C) that were used as the basis for this study in the lower Calapooia watershed, Linn County, Oregon.

on aquatic vertebrates, water quality, and avian wildlife, while balancing economic impacts on farmers, is only beginning to be addressed in this region. Although efforts to understand the impacts on wildlife of the Conservation Reserve Program and other incentives programs have been active in the Midwest for years (Hohman and Holman 2000), we are not aware of similar efforts in the Willamette Valley. Furthermore, most previous work on associations of wildlife with riparian areas in the Midwest and in forested areas of the Northwest has focused on breeding birds. Few studies have addressed associations in the winter when stream systems in the Northwest expand to their greatest extent (Wigington et al. 2005). Consequently, our goal was to understand the potential for three types of riparian vegetation to provide habitat for a suite of bird species that winter in the Willamette Valley. Our objectives were: (1) quantify patterns of winter bird use among nine 1-km^2 study sites centered on grass-, shrub- and tree-dominated riparian areas; (2) assess the relative contribution of vegetation and streams to observed patterns; (3) identify landscape characteristics influencing detections of birds in these study sites; and (4) develop conservation practice management hypotheses that can be tested through implementation of USDA Farm Bill conservation programs by farmers.

Study Area

Our study was conducted in nine 1-km^2 study sites centered on ephemeral streams in the lower Calapooia River watershed in the south central Willamette Valley, Oregon. The history of settlement and land use in the area is described in detail by Boag (1992) with current and likely future conditions described by Hulse et al. (2002). The area has been intensively managed for grass seed production for the past 60 years, with many fields also grazed by sheep in the winter.

The Willamette Valley is the warmest and driest area west of the Cascades and is characterized by wet-mild winters and warm-dry summers (Franklin and Dyrness 1988). Hence, streams that we sampled flowed all winter but became dry or ran intermittently during the summer. All nine study areas were on privately owned farms. We attempted to select sites randomly within the watershed, but were restricted to those sites meeting our study design where we could also obtain permission to gain access to the land, so only four of the nine sites were randomly chosen from a larger pool of sites.

Methods

Each study site represented a mosaic of fields, streams, roads, fences, and vegetation patches. Within the center of each 1-km^2 site, we established a grid of nine sampling points with the center row of points falling on the stream bank. All adjacent points were 250 m apart and represented subsamples designed to characterize the interior 56 ha of each site. We sampled three replicates of three riparian zone types: grass-, shrub-, and tree-riparian. The three grass-riparian sites had streams bordered by grass fields (they were farmed to the stream edge) (Figure 1a). The three shrub-riparian sites were bordered by shrubby regrowth (largely *Rubus* spp., *Salix* spp., and *Alnus* spp.) along each stream bank (Figure 1b). The three tree-riparian sites were bordered by trees, predominantly Oregon ash (*Fraxinus latifolia*) with lesser representation of Oregon oak (*Quercus garryana*) and planted poplars (*Populus* spp.) (Figure 1c).

Birds were counted from mid-December 2003 to mid-March 2004 by one observer (DB). All birds seen or heard were counted during two 10-minute visits to each point in the morning (0800-1130) and two 10-minute visits to each point in the afternoon (1300-1630). A visit was made to each site before any subsequent visits were made to a site, ensuring that sampling was well distributed among sites over the entire sampling period. Using four visits per site is consistent with other studies of bird communities in agricultural (Sanders and Edge 1998, Perkins et al. 2003) and forested (Chambers and McComb 1997, McGarigal and McComb 1995) settings and was more intensive than several other studies in the Midwest (Lokomoen and Beiser 1997, Delisle and Savidge 1997). Counts were conducted on days with little or no rain or wind. The distance from the sample point to each bird was estimated to the nearest 5 m out to 125 m. Birds observed beyond 125 m from a point and those flying over were excluded from analyses. The number of detections per species per point was averaged over each site and was used as the basis for analysis (n=9).

We characterized the structure and composition of each site based on digital ortho-photos to assess associations with bird detections. For each site we estimated (and confirmed with 100% ground truthing) percent cover by trees >10 cm dbh, shrubs, grasses, forbs, bare ground, buildings, and mulch (and other dead vegetation). We also estimated total lengths of streams, tree-field edges, shrub-field edges, roads, and fences. In addition, the following ground plot data were collected within a 50-m radius of each point: maximum vegetation height; percent cover by bare ground, trees, shrubs, grass mulch (and other dead vegetation), and forbs; distances to the nearest stream, other water source (e.g., flooded wetlands), tree, road, building, and fence; stream bank full width; and number of snags >10 cm dbh, trees 10-25 cm dbh, trees >25-50 cm dbh, and trees >50 cm dbh. These plot characteristics were averaged within each site.

We compared the number of detections and detection distances (Norvell et al. 2003) for species with >30 detections among grass-, shrub- and tree-riparian sites using an Analysis of Variance with Scheffe's multiple means comparison (to control experiment-wise error rates). We also compared the number of detections of all bird species combined and number of species detected among these same three riparian vegetation types using the same techniques. We calculated the difference in average detections per point at upland sample points (>200 m from streams) from average detections per point at riparian sample points for each study site. Differences that were positive indicated a stronger contribution of the riparian area detections to the total than upland detections. Negative differences indicated a greater contribution of upland detections to the total. Using these differences as the response variables, we assessed if relative contributions of riparian and upland detections were consistent among the three riparian vegetation types.

We also used simple linear correlation to identify characteristics associated with bird detections among the nine sites. We used these results only to suggest patterns because multiple correlations greatly inflate the experiment-wise error rates. Because tree cover and tree-field edge length emerged as strong associates for many species, we developed regression relationships to hypothesize how study-site tree cover and tree-field edge length might be used to infer winter bird species richness on these study sites. All analyses were conducted in SAS (SAS Institute 1990).

Results

Three times as many species and 20 times more total birds (all species combined) were observed in tree-riparian sites as in grass-riparian sites (Table 1). Shrub-riparian areas also yielded more bird detections than grass-riparian areas (Table 1). These patterns were consistent for three of the 11 individual species with >30 detections: American

TABLE 1. Average (SE) detections per point (within 125 m) on nine 1-km^2 study sites centered on riparian areas bordered by trees (n = 3), shrubs (n = 3), and grass fields (n = 3), Lower Calapooia watershed, Linn County, Oregon, winter 2003-04. Means with different letters differ at *P* < 0.05 based on Scheffe's multiple means comparison test. Overall ANOVA significance is also provided.

	Riparian vegetation type			
Species	Grass	Shrub	Tree	*P*
American robin (*Turdus migratorius*)	0.1_b (0.1)	2.3_{ab} (1.4)	13.1_a (4.3)	0.0249
Black-capped chickadee (*Poecile atricapilla*)	0.0_b (0.0)	0.04_b (0.4)	1.6_a (0.43)	0.0060
Common snipe (*Gallinago gallinago*)	0.07 (0.07)	1.41 (0.83)	0.74 (0.69)	0.3781
Golden-crowned sparrow (*Zonotrichia atricapilla*)	0.0 (0.0)	0.0 (0.0)	1.44 (1.1)	0.2454
Mallard (*Anas platyrhynchos*)	0.30 (0.2)	0.59 (0.3)	0.44 (0.1)	0.6721
Northern flicker (*Colaptes auratus*)	0.04 (0.04)	0.15 (0.1)	0.56 (0.2)	0.0896
Oregon junco (*Junco hyemalis*)	0.0 (0.0)	2.70 (1.4)	0.7 (0.6)	0.1535
Red-winged blackbird (*Agaelius phoeniceus*)	0.04 (0.04)	1.30 (1.2)	0.89 (0.7)	0.5799
Savannah sparrow (*Passerculus sandwichensis*)	0.37 (0.1)	1.26 (1.1)	0.11 (0.1)	0.4856
Song sparrow (*Melospiza melodia*)	0.30_b (0.2)	1.89_{ab} (0.8)	4.22_a (1.2)	0.0426
European starling (*Sturnus vulgaris*)	0.00 (0.0)	2.96 (2.0)	7.96 (4.4)	0.2002
All species combined[1]	1.8_b (0.1)	17.2_b (6.8)	36.9_a (6.3)	0.0100
Species richness	5.3_b (0.9)	12.0_b (1.5)	18.3_a (2.0)	0.0031

[1]Only species with >30 detections are listed individually, but all species regardless of number of detections are included in these calculations. Other species detected in study sites with grass- (G), shrub- (S), and tree- (T) riparian areas include: Bewick's wren (*Thryomanes bewickii;* T), Brewer's blackbird (*Euphagus cyanocephalus;* G, S, T), brown creeper (*Certhia americana;* T), bushtit (*Psaltriparus minumus;* T), golden-crowned kinglet (*Regulus satrapa;* T), green-winged teal (*Anas crecca;* G, S, T), house finch (*Carpodacus mexicanus;* G, S, T), horned lark (*Eremophila alpestris,* S), house wren (*Troglodytes aedon;* T), killdeer (*Charadrius vociferous;* S, T), mourning dove (*Zenaida macroura;* S, T), northern harrier (*Circus cyaneus;* S), northern shoveler (*Anas clypeata;* S), common raven (*Corvus corax;* G), ruby-crowned kinglet (*Regulus calendula,* T), spotted towhee (*Pipilo maculatus;* S, T), red-tailed hawk (*Buteo jamaicensis;* S, T), western scrub-jay (*Aphelocoma californica;* S, T), California quail (*Callipepla californica;* T), white-crowned sparrow (*Zonotrichia leucophrys;* T), western meadowlark (*Sturnella neglecta;* G), wood duck (*Aix sponsa;* T)

robin, black-capped chickadee and song sparrow (Table 1). We were not able to detect differences among study site types for eight other species, probably due to small sample sizes and high variability among sites. However the average number of detections of these eight species was greater in the shrub-riparian study sites, tree-riparian study sites or both compared to grass-riparian sites (Table 1).

We did not detect significant differences in detection distances among riparian vegetation types for any species (*P* > 0.06) except black-capped chickadees, indicating that it is likely that our index of abundance (bird detections/point/day) out to 125 m is a relatively consistent measure of detection probabilities for most species. Indeed for many species, detections were made beyond 250 m, but not included in analyses due to the increasing risk of double-counting individuals from multiple points in the site. The average detection distance for chickadees in tree-riparian sites was greater than in shrub-riparian sites (*P* < 0.02) indicating that there was a lower probability of detecting this species in shrub-riparian than tree-riparian sites. Hence, although caution should be exercised when interpreting differences

TABLE 2. Difference in average (SE) detections per point (within 125 m) between riparian and upland sample points on nine 1-km² study sites centered on riparian areas bordered by trees (*n* = 3), shrubs (*n* = 3), and grass fields (*n* = 3), Lower Calapooia watershed, Linn County, Oregon, winter 2003-04. Means with different letters differ at $P < 0.05$ based on Scheffe's multiple means comparison test. Overall ANOVA significance is also provided.

Species	Riparian vegetation type			*P*
	Grass	Shrub	Tree	
American robin	-0.02 (0.02)	3.82 (2.1)	18.17 (19.0)	0.5090
Black-capped chickadee	0.0_b (0.0)	0.08_b (0.08)	4.28_a (1.03)	0.0035
Common snipe	-0.11 (0.1)	3.12 (1.8)	1.22 (1.1)	0.2447
Oregon junco	0.0 (0.0)	7.0 (3.5)	1.89 (1.4)	0.1419
Golden-crowned sparrow	0.0 (0.0)	0.0 (0.0)	-2.17 (1.6)	0.2454
Mallard	0.89 (0.6)	1.03 (0.5)	1.33 (0.3)	0.8142
Northern flicker	0.07 (0.1)	0.36 (0.2)	0.83 (0.8)	0.5301
Red-winged blackbird	0.11 (0.1)	-0.97 (0.9)	-1.33 (1.1)	0.4739
Savannah sparrow	-0.18 (0.3)	-2.12 (1.9)	-0.17 (0.1)	0.4216
Song sparrow	-0.11 (0.2)	3.87 (1.8)	8.83 (5.0)	0.2031
European starling	0.00 (0.0)	8.30 (6.0)	16.72 (11.7)	0.3609
All species combined[1]	0.49 (0.9)	26.5 (11.2)	59.61 (24.0)	0.0880

[1]Only species with >30 detections are listed, but all species regardless of number of detections are included in these calculations.

among riparian vegetation types for this species, we observed four times as many chickadees in tree-riparian sites as in shrub-riparian sites.

The difference in detections between upland and riparian points varied among riparian vegetation types only for black-capped chickadees, which exhibited a strong association for riparian areas bordered by trees (Table 2). Other species also tended to be detected more frequently at riparian points: American robin, common snipe, Oregon junco, mallard, northern flicker, song sparrow, and European starling. Red-winged blackbirds, savannah sparrows and golden-crowned sparrows tended to be associated with uplands.

The number of species detected within the nine sites was associated with the tree cover (from 0-16.5%) and the length of the tree-field edge (from 0-4200 m/km²) (Table 3). These associations

TABLE 3. Associations ($P < 0.05$) between average bird detections per point (within 125 m) and study site characteristics on nine 1-km² Oregon, winter 2003-04.

Characteristic	Species					
	American robin	Black-capped chickadee	Common snipe	Oregon junco	Mallard	Northern flicker
Length of stream	-0.70					
Average stream width					+0.72	
Length of tree-field edge	+0.78	+0.97				+0.84
Length of shrub-field edge					+0.75	
Percent cover by trees	+0.73	+0.92				+0.84
Percent cover by grass fields				-0.74		
Percent cover by shrubs						
Average tree cover/point	+0.78	+0.99				+0.75
Average shrub cover/point		+0.78				+0.97
Average grass cover/point				-0.76		
Average forb cover/point			+0.90	+0.66		
Average snags > 10 cm dbh/point	+0.71					+0.71
Average trees 10-25 cm dbh/point	+0.87					
Average trees 25-50 cm dbh/point	+0.97	+0.77				
Average trees > 50 cm dbh/point	+0.64	+0.90				

are curvilinear and asymptotic over the range of conditions that we sampled (Figure 2). Within the range of conditions sampled, winter bird species richness was greatest in sites with 13% tree cover (13 ha/km^2) or 3.3 km/km^2 of tree-field edge. Tree cover or length of tree-field edge were also positively associated with total bird detections and detections of song sparrows, American robins, black-capped chickadees, golden-crowned sparrows, and northern flickers (Table 3).

Detections of Oregon juncos, song sparrows, and northern flickers were associated with increasing shrub cover (Table 3). Total bird detections and species richness were also correlated with shrub cover. A variety of other characteristics were associated with detections (Table 3), and these associations were largely consistent with life history information describing foraging habitat for each species. For instance, stream characteristics were associated with mallard detections and forb cover was associated with red-winged blackbirds, common snipe, savannah sparrows, and Oregon juncos.

Discussion

Our results are consistent with the findings of investigators working on breeding bird communities in Midwest agricultural areas. Adding woody

A.

B.

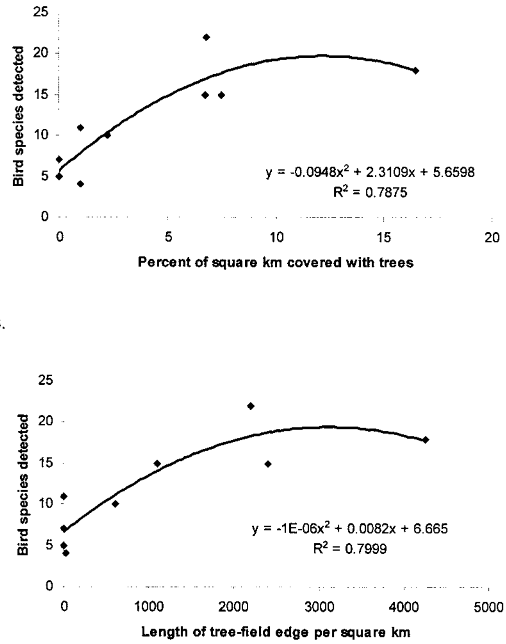

Figure 2. Relationships between bird species richness (based on detections < 125 m from nine sampling points per study site) and tree cover per study site (A), and length of tree-field edge per study site (B), lower Calapooia watershed, Linn County, Oregon.

study sites centered on tree- (n = 3), shrub- (n = 3), and grass-riparian areas (n = 3), Lower Calapooia watershed, Linn County, Oregon,

	Species					
Characteristic	Red-winged blackbird	Golden-crowned sparrow	Song sparrow	European starling	All birds	Species richness
Length of stream				-0.71		
Average stream width						
Length of tree-field edge		+0.83	+0.73		+0.79	+0.79
Length of shrub-field edge						
Percent cover by trees		+0.86	+0.69		+0.77	+0.76
Percent cover by grass fields		+0.94				
Percent cover by shrubs			+0.69			
Average tree cover/point					+0.72	+0.70
Average shrub cover/point			+0.91		+0.68	
Average grass cover/point						
Average forb cover/point	+0.97		+0.71			
Average snags > 10 cm dbh/point						
Average trees 10-25 cm dbh/point					+0.81	+0.78
Average trees 25-50 cm dbh/point					+0.82	+0.80
Average trees > 50 cm dbh/point						

vegetation to a landscape that increases the vertical structure, horizontal complexity, and area of woody vegetation will increase the number or abundance of native bird species (Stauffer and Best 1980, Best 1983, Sanders and Edge 1998, and Perkins et al. 2003). Perkins et al. (2003) used an approach similar to ours in eastern Nebraska agricultural areas and reported a threshold initiating a rapid decline in abundance of two breeding bird species when the forested portion of an agricultural study site dropped below 14-22%. Theoretical thresholds also have been generated suggesting that when <20% of a landscape is in a particular patch type (e.g., forest), abundance of species selecting that patch type declines rapidly (Fahrig 1997). Such general guidelines may be useful when considering conservation and restoration of riparian woodlands in the Willamette Valley until more detailed data come available.

Provisions of the recent USDA Farm Bill Title II (Conservation) make incentive payments available to grass seed farmers. In the Willamette Valley, practices that include recovery of shrub and tree cover might provide habitat for a greater number of over-wintering bird species. We estimate that shrub or tree cover encompassing up to 13% of each km^2 of farmland would increase species richness of birds during the winter. Restoring areas of trees and shrubs along streams benefits species that use both open water and tree or shrub cover (e.g., mallards, Table 3), while also benefiting species that need one or the other (e.g., black-capped chickadees, Table 3). Tree and shrub patches along fencerows and perhaps roads also could contribute to increasing the number of over-wintering bird species in areas farmed for grass seed.

It is possible to achieve multiple resource management goals in the central Willamette Valley. If providing habitat to support a range of bird species is a goal of farmers, then they could estimate the marginal increase in winter bird species richness per unit grass field converted to trees based on the relationships portrayed in Figure 2. It may be possible to determine the economic trade-off between income forgone by not farming poorly drained portions of fields where crop yield is suppressed and substitute USDA Farm Program payments for establishing conservation practices in those areas that provide habitat to support a suite of bird species (Steiner et al. 2004).

Further research is needed to determine whether implementation of conservation practices in managed agricultural landscapes in the central Willamette Valley would actually enhance habitat for the species that we detected. Repeating our work during the breeding season could also provide more comprehensive guidelines. Until additional data are available, we suggest providing both strips and blocks of woody cover if the goal is to increase over-winter bird species richness.

Another guideline that could be used to increase habitat for a suite of organisms in this region is to consider the range of vegetative conditions likely represented over the region over long time periods. Conservation practices that are more likely to fall within the range of variability in conditions represented historically may be expected to accommodate a wide range of species (Landres et al. 1999). Given the historic range of conditions represented in the central Willamette Valley, many of the species we detected are likely well-adapted to a mix of vegetation types across the landscape (Hulse et al. 2002), and many of the shrub and tree patches historically were widely distributed along stream courses (Boag 1992). Using historical patterns as a template, retaining or restoring 10-15% of a square km to trees and shrubs in areas where tree cover historically occurred may be an effective strategy.

Caution should be exercised in applying the guidelines above too generally because some species are adversely affected by a proliferation of abrupt edges and may find better quality habitat in large unbroken patches (Best 2000). It also is important to realize that these approaches represent hypotheses that should be tested in a manipulative experiment to demonstrate cause and effect relationships. These kinds of experiments are needed to document the actual impacts of habitat restoration in support of USDA Farm Bill conservation payment incentives.

The geographical scope of this study is restricted to ephemeral streams flowing through farms in the central Willamette Valley during the winter. We sampled three replicates of each riparian vegetation type, limiting our ability to detect differences that might become apparent with larger sample sizes. By sampling birds for one winter we could not account for variability between years and did not address long-term population trends of winter birds. Also, we did not address potential associations of riparian vegetation types during the breeding season when adverse edge effects could be more noticeable (Perkins et al. 2003).

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