Agricultural Buffers and Wildlife Conservation: A Summary About Linear Practices

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ABSTRACT Conservation practices such as filter strips, grassed waterways, buffers, contour strips, riparian buffers, windbreaks and shelterbelts are eligible under a variety of USDA programs. Most were originally designed to provide benefits regarding reduced soil erosion and improved water quality. Most often grasses, or mixtures of grasses and forbs, are used in these practices, although establishment of trees and shrubs is encouraged in some practices. The small area and high edge-area ratios limit the usefulness of these practices for wildlife. Scientific evidence suggests that enrolling land in linear practices has accumulated in recent years, although most studies still focus heavily on benefits to birds and do not address the larger questions of the animal communities. With careful planning and management, applying linear practices widely within an agricultural landscape could be expected to have positive wildlife benefits compared with continued intensive row cropping.

In Phase I of the Conservation Effects Assessment Project, Clark and Reeder (2005) provided a review of the effects of the Continuous Conservation Reserve Program (CCRP) on the conservation of wildlife in agricultural landscapes. Whereas the first review took a programmatic viewpoint, this chapter summarizes the available research on individual conservation practices that would generally be called "linear or narrow" practices. Grass filter strips or riparian buffers are the most widely used of the practices that we will review. While some of these practices are available in a number of USDA conservation programs, the majority of these practices are available to producers through the CCRP.

As Clark and Reeder (2005) emphasized, the linear shape, small area, and high edge-area ratios have limited the potential direct benefits of linear practices for wildlife. Yet, the replacement of annual crops with perennial habitat, even in small patches, has some conservation benefit. Evidence that wildlife use these linear habitat patches in agricultural landscapes, whether part of a specific conservation program or not, is mounting, although the research is most heavily focused on avian populations and communities. The greatest wildlife benefits of conservation practices and programs accrue when relatively large areas are converted from annual cropland to perennial habitat. This point is easily illustrated by the well-known benefits of enrollment of large areas into the Conservation Reserve Program (CRP) (Reynolds 2000, Ryan 2000), especially when the habitat is configured in blocks that were the rule under the general signup (Clark et al. 1999, Horn et al. *in press*). Clark and Reeder (2005) also emphasized that the landscape context (i.e., the habitat in the landscape surrounding the project) influences the benefits of linear practices. So a challenge for land managers and producers interested in wildlife benefits is to consider whether practices can be "strategically" located in the landscape to target wildlife benefits. In fact, this landscape perspective is almost in direct conflict with the application of specific linear conservation practices on individual farm units. There is very little research in the wildlife literature that quantifies the tradeoffs between applications of piecemeal conservation practices versus landscape management of collections of practices. Careful planning and sustained management are keys to gaining the desired wildlife benefits from these plantings. Sustaining wildlife populations and community diversity depends on the functional relationships of species to habitat and

Table 1. Linear and Potentially Linear Conservation Practices on CRP Acres as of April 2005. Adapted from FSA (2005).

Practice		General Signup		Continuous Signup		Total	
		Acres	%	*Acres*	%	*Acres*	%
CP1	New Intro. Grasses And Legumes	3,268,929	10	182,813	6	3,451,743	10
CP2	New Native Grasses	6,450,216	20	82,281	3	6,532,497	19
CP3	New Softwood Trees (Not Longleaf)	427,519	1	694	0	428,213	1
CP3A	New Longleaf Pines	184,995	1	0	0	184,995	1
CP3A	New Hardwood Trees	526,105	2	9202	0	535,307	2
CP4	Permanent Wildlife Habitat	2,315,297	7	41,600	1	2,356,897	7
CP5	Field Windbreaks	831	0	74,581	3	75,412	0
CP8	Grass Waterways	1011	0	108,830	4	109,841	0
CP9	Shallow Water Areas For Wildlife	1943	0	48,536	2	50,479	0
CP10	Existing Grasses And Legumes	15,145,051	48	49,564	2	15,194,614	44
CP11	Existing Trees	1,093,037	3	357	0	1,093,394	3
CP12	Wildlife Food Plots	75,473	0	1743	0	77,216	0
CP13	Vegetative Filter Strips	29,458	0	0	0	29,458	0
CP15	Contour Grass Strips	36	0	78,403	3	78,439	0
CP16	Shelterbelts	364	0	29,466	1	29,830	0
CP17	Living Snow Fences	2	0	4252	0	4254	0
CP18	Salinity Reducing Vegetation	0	0	295,130	10	295,130	1
CP 19	Alley Cropping	52	0	0	0	52	0
CP21	Filter Strips (Grass)	0	0	972,156	33	972,156	3
CP22	Riparian Buffers	0	0	712,093	24	712,093	2
CP23	Wetland Restoration	1,569,334	5	91,859	3	1,661,193	5
CP23	Wetland Restoration (Floodplain)	0	0	68,047	2	68,047	0
CP23A	Wetland Restoration (Non-floodplain)	0	0	4832	0	4832	0
CP24	Cross Wind Trap Strips	0	0	687	0	687	0
CP25	Rare And Declining Habitat	656,128	2	38,292	1	694,420	2
CP26	Sediment Retention	0	0	6	0	6	0
CP29	Wildlife Habitat Buffers (Marg Past)	0	0	16,789	1	16,789	0
CP30	Wetland Buffer (Marg Past)	0	0	11,544	0	11,544	0
CP31	Bottomland Hardwood	0	0	10,030	0	10,030	0
CP33	Upland Bird Habitat Buffers	0	0	33,477	1	33,477	0
	Unknown	-21	0	1018	0	997	0
TOTAL		**31,745,760**	**100**	**2,968,282**	**100**	**34,714,042**	**100**

landscape features. Individual conservation practices may not provide the life requisites to sustain satisfactory reproductive success and survival, although data on the functional value of practices on taxa using these plantings is generally limited (Clark and Reeder 2005).

The linear practices that we review (Table 1) are nested in a larger framework of agricultural conservation practices. In Table 1 we present designations used by FSA and have provided an appendix for cross reference with designations used by NRCS. Many of the practices available to producers under a variety of USDA programs could be configured in a linear fashion, depending on the characteristics of the site (Table 2). In this chapter we focus more narrowly on practices that are linear by design, although the principles highlighted in the research reviewed here are applicable to most linear perennial habitat practices.

The standards outlined for the general practice "Conservation Cover" apply to any practice that retires land from agricultural production and establishes permanent vegetative cover (NRCS 2000a). In practice, standards that were established for practices like CP1 (new introduced grasses and legumes), CP2 (new native grasses) and other conservation cover practices recommend following general principles (e.g., avoid the use of invasive species) that should be applied to all practices in addition to the specific guidelines laid out in a specific practice standard. There should be flexibility in conservation practices such that the plantings are suited to the site and the goals of the landowners. For example, the practice standard for Cross Wind Trap Strip specifies that plant materials used for the practice should be selected based on their level of suitability to the site and compatibility with secondary goals such as provision of wildlife food and cover (NRCS 2005). Thus, the rules allow for such strips to be planted with warm or cool season grasses, with or without legumes or other forbs.

Landowners and managers always balance myriad goals and requirements in the planning and implementation of conservation practices. This chapter is designed to assist resource managers weighing the merits of linear conservation practices in relation to wildlife habitat benefits. This summary of practices focuses on the wildlife benefits, although there is very surely a link between the terrestrial and aquatic communities. We have grouped practices into general categories based on physical structure (herbaceous and tree/shrub) and location (riparian and in-field), so the chapter is organized into four sections based on combinations of those categories. In the sections that follow, we list a number of specific practices that fit under the broader categories.

Herbaceous Practices

In the Midwest, where the intensity of row crop agriculture is the highest, herbaceous practices dominate (Table 2). This fact stems from several causes: a) the pre-agricultural native vegetation was primarily prairie, so natural resource agencies have encouraged the re-establishment of grasses and forbs rather than trees, b) landowners are sometimes averse to the idea of planting trees in an area that has been cleared of trees for agriculture, c) and planting trees is more work and capital-intensive than planting herbaceous vegetation, and trees are also more costly to remove once a program ends.

Research on herbaceous buffers has shown that these practices host greater abundances of wildlife than surrounding row crop fields. Studies of avian use of agricultural areas has demonstrated that, even though some bird species such as vesper sparrows (*Pooecetes gramineus*), dickcissels (*Spiza americana*), and red-winged blackbirds (*Agelaius phoeniceus*) are known to nest in row crop fields, abundances in herbaceous buffers are an order of magnitude greater than in row crops (Best 2000). Grassland specialist bird species use buffer strips in comparatively small numbers (Kammin 2003, Knoot 2004, Henningsen and Best 2005).

Landscape context is particularly important for some species using herbaceous buffers. These species can exhibit behavioral or demographic responses to the proximity of other landscape features, especially trees and shrubs and edges (Ries and Debinski 2001, Fletcher and Koford 2003, Henningsen 2003), as well as to the landscape composition (e.g., Clark et al. 1999, Horn et al. *in press*, Knoot 2004). The width, vegetative composition and structure, and landscape context of these practices all affect wildlife communities using them (Clark and Reeder 2005).

Table 2. Acres of linear conservation practices installed on CRP and CCRP acreage as of April 2005. (Adapated from FSA 2005.)

States	Field Wind-breaks	Grass Water-ways	Contour Grass Strips	Shelter-belts	Living Snow Fence	Filter Strips	Riparian Forest Buffer	Cross Wind Trap Strips	Field Bor-ders
Alabama	0	47	188	0	0	968	27,940	0	36
Alaska	0	1	0	0	0	0	185	0	0
Arkansas	0	23	0	0	0	5,362	39,785	0	17
California	0	0	0	0	0	0	5,248	0	0
Colorado	1,313	985	444	4,002	37	406	801	28	0
Connecticut	0	0	0	0	0	20	63	0	0
Delaware	0	4	0	0	0	1,403	158	0	0
Florida	0	0	0	0	0	5	68	0	0
Georgia	0	85	41	0	0	1,235	1,320	0	75
Idaho	512	13	64	220	73	1,212	6,928	0	0
Illinois	2,501	28,522	2,011	138	36	147,441	103,759	0	16,259
Indiana	2,172	15,216	208	25	0	56,740	4,841	0	2,383
Iowa	5,999	29,909	30,373	1,949	229	239,909	61,995	41	1,120
Kansas	1,567	7,759	5,482	595	70	26,802	4,765	184	5,294
Kentucky	8	3,532	61	0	0	33,414	13,936	0	806
Louisiana	0	41	0	0	0	636	4,339	0	0
Maine	0	26	0	0	0	126	197	0	0
Maryland	0	228	0	0	0	40,447	16,793	0	7
Massachusetts	0	1	0	0	0	62	5	0	0
Michigan	1,788	803	16	82	3	42,295	3,115	0	0
Minnesota	8,741	4,408	1,273	3,513	2,961	155,354	43,861	7	0
Mississippi	0	61	38	0	0	7,994	132,542	0	196
Missouri	114	1,832	2,232	36	0	42,338	25,307	0	1,674
Montana	409	97	0	260	18	142	2,441	27	0
Nebraska	26,256	1,825	583	2,144	145	20,916	3,136	46	955
New Hampshire	0	0	0	0	0	163	23	0	0
New Jersey	8	21	4	0	0	133	21	0	0
New Mexico	0	0	0	0	0	0	7,330	0	0
New York	11	72	4	0	0	589	10,197	0	0
North Carolina	22	149	0	13	0	6,918	28,220	0	500
North Dakota	4,237	128	0	3,881	306	8,595	575	10	0
Ohio	2,182	7,255	18	88	3	49,656	4,439	4	781
Oklahoma	44	316	2	37	4	1,033	1,483	0	99
Oregon	4	73	19	2	0	2,256	20,438	0	0
Pennsylvania	4	513	133	0	0	1,831	12,349	0	0
Puerto Rico	0	0	0	0	0	0	94	0	0
South Carolina	79	74	0	0	0	6,313	27,422	0	965
South Dakota	16,940	1,168	131	12,743	325	7,262	3,398	15	74
Tennessee	0	171	78	0	0	9,617	5,582	0	1,618
Texas	43	2,230	251	34	0	1,958	25,165	257	571
Utah	5	6	0	0	0	12	154	0	0
Vermont	5	1	0	0	0	147	1,327	0	0
Virginia	3	43	0	0	3	4,347	17,710	38	47
Washington	16	489	33,599	9	0	50,184	19,930	14	0
West Virginia	0	0	0	0	0	49	1,749	0	0
Wisconsin	242	1,700	1,186	26	39	25,312	16,264	0	0
Wyoming	187	13	1	33	4	9	4,654	17	0
Total	**75,412**	**109,841**	**78,439**	**29,830**	**4,254**	**1,001,614**	**712,094**	**687**	**33,477**

Riparian

CP21—Filter Strip

Filter strips are areas of herbaceous vegetation planted between row crop fields and bodies of water. Filter strips are designed to reduce the sediment and contaminant load in surface runoff, to provide habitat for wildlife and beneficial insects, and to enhance watershed functions.

The filter strip is one of the most studied practices with regard to wildlife benefits. The available research suggests that filter strips are valuable to wildlife because they create areas of perennial vegetation that are less disturbed relative to surrounding annual row crops fields. Despite benefits associated with perennial cover, generally, wildlife community composition is not as rich, nor reproductive success as sustaining in filter strips as they are in natural grassland habitats.

Filter strips host a variety of wildlife, including small mammals, arthropods, and birds. However, dominant species within these groups are primarily habitat generalists, like deer mice and red-winged blackbirds. Diverse plantings favor a richer fauna, especially of arthropods, as structural heterogeneity provides a variety of microhabitats. Wider plantings may also support a greater variety of species, because adding interior is more favorable for species that exhibit edge-averse behavior.

Research on the effect of filter strip width has been evaluated for birds and butterflies. In Illinois filter strips, Kammin (2003) found no relationship between strip width and abundance or richness of birds. In Iowa filter strips, the abundance of the eastern meadowlark (*Sturnella magna*) was associated with width (Henningsen 2003). Henningsen (2003) found nest success of only one species, the red-winged blackbird, was positively associated with width of the filter strip. The maximum width of the filter strips in these studies was 40 m (131 ft). Perhaps, for vagile organisms such as birds, the effects of width are not manifested in this range. A study of filter strips 18 to 167 m (59 to 548 ft) wide in Minnesota showed that the diversity of butterflies, as well as the abundance of certain large-bodied butterfly species, was positively associated with strip width (Reeder et al. 2005). The effects of width may be dependent upon the relative vagility of the species of interest and be limited by the range of widths evaluated.

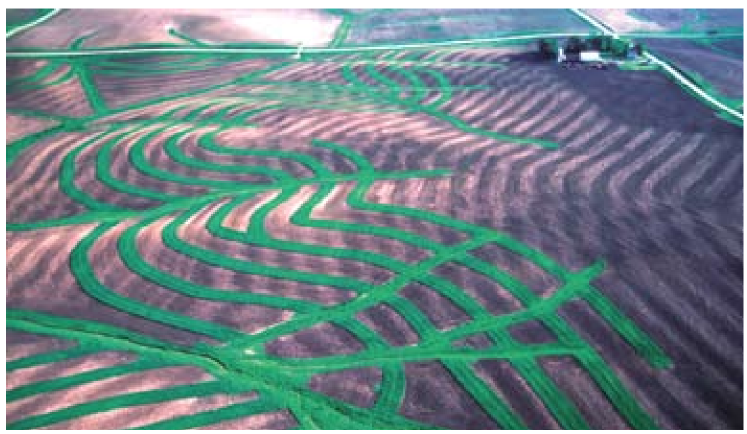
Habitat structure also plays an important role in determining wildlife community structure in filter strips. Vegetative diversity is positively correlated with arthropod diversity and abundance (Benson 2003, McIntyre and Thompson 2003). Arthropods are a primary food source of birds, including pheasant chicks and grassland passerines.

The influence of landscape context on wildlife communities in filter strips has yet to be directly addressed in the literature. It is clear, however, that the configuration of herbaceous cover on the landscape affects the reproduction and distribution of pheasant populations (Clark et al. 1999).

In-field

CP8—Grassed Waterway

Grassed waterways are an in-field conservation practice, engineered to direct runoff within a field and prevent erosion and gully formation. They are typically quite narrow (up to 100 ft wide) and are often mowed to keep the grasses short to allow optimal water flow. The combination of being embedded in a row crop matrix rather than being along a field edge, being narrow, and being composed of a relatively homogenous grass mixture leads grassed waterways to offer less habitat potential for wildlife than filter strips or riparian forest buffers. In fact, providing wildlife habitat is not among the stated purposes of this practice (NRCS 2000b). However, grassed waterways host a range of wildlife, from small mammals and snakes to nesting birds, so wildlife considerations can be important in planning and implementing grassed waterways.



Grassed waterway in a Georgia agricultural field. (Photo courtesy of USDA NRCS)

A heavy proportion of the species found in grassed waterways are generalists. For example, red-winged blackbirds accounted for 50 percent of the total bird abundance in Iowa grassed waterways, while grassland specialist species such as grasshopper sparrows (*Ammodramus savannarum*), savannah sparrows (*Passerculus sandwichensis*), and vesper sparrows (*Pooecetes gramineus*) were found in fewer than five of 33 grassed waterways surveyed (Knoot 2004).

Knoot (2004) reported that presence of plains garter, eastern garter, and brown (*Storeria dekayi*) snakes was positively correlated with the width of grassed waterways in Iowa. However, in her analyses on the avian community, she found a predictive relationship of grassed waterway width for only 2 of 7 species of songbirds, and the direction of the relationship contrasted. These results suggest that perhaps, for a practice as narrow as a grassed waterway, it is difficult to detect an effect of width on vagile species such as birds. For such species, this practice may represent 100 percent edge habitat.

The effect of habitat structure on wildlife in grassed waterways varies by species. In grassed waterways in Iowa, vegetation vertical density was positively associated with the presence of dickcissels, common yellowthroats (*Geothlypis trichas*), and red-winged blackbirds (Knoot 2004). Occurrences of smooth green snakes (*Lioclonorophis vernalis*) in these grassed waterways were positively associated with litter cover, but eastern garter snake (*Thamnophis sirtalis*) occurrences were negatively correlated with litter.

Because grassed waterways are embedded in row crop fields, they are driven over by farm machinery, in contrast with most other strip cover practices. Farm equipment caused 9 percent of nest failures in Iowa grassed waterways, but the nest failure rate caused by such disturbance is small in comparison with the 80 percent of failures caused by predation in this study (Knoot 2004).

CP33—Habitat Buffer for Upland Birds (Field Border)

Field borders are areas of managed, herbaceous vegetation, which can be planted along crop field edges regardless of the erosion potential of the border. In general, such buffers can be used to reduce erosion from wind and water, protect soil and water quality, manage harmful insect populations, and provide wildlife food and cover. CP33 was recently created as part of a national northern bobwhite conservation initiative. This practice is typically narrow and can be planted to warm season grasses, legumes and forbs.

During a study of bird response to experimentally established field borders in Mississippi, Smith (2004) found that abundances of dickcissel (*Spiza americana*) and indigo bunting (*Passerina cyanea*) were double that of areas not planted with field borders. Overall bird abundance and species richness was greater in bordered edges than non-bordered edges, although diversity did not differ between treatments. Additionally, during winter, edges of fields with borders hosted a higher abundance of sparrows than those without field border buffers (Smith et al. 2005a).

The results presented by Smith et al. (2005a) also indicate that field borders will only contribute meaningfully to bobwhite quail conservation if they make up a significant proportion (5 percent to 10 percent) of the landscape. This is consistent with the principal outlined by Clark and Reeder (2005) that a coordinated, landscape-level approach to locating practices in the landscape stands to offer the most benefit for wildlife.

Terraces

Terraces are earth embankments built up across the field slope and thus have a steep profile and are not very wide. Terraces are so narrow that their effect on conservation of grassland birds is minimal, and changes in terrace management practices are unlikely to improve their habitat quality (Hultquist and Best 2001).

CP15—Contour Grass Strip, CP24—Cross Wind Trap Strip

To our knowledge, these practices have not been the specific focus of wildlife research. However, they are similar to grassed waterways in a couple of key ways — they are areas of grass that are narrow, and they are embedded in a row crop matrix. Contour grass strips occur on slopes, however, they are often planted in an alternating pattern with crops and are generally wider than some linear practices, thus enhancing their value to wildlife.

Tree/Shrub Practices

In the Midwest, where the predominant historic vegetation is grassland, buffers with shrubs and small trees often have greater species richness than herbaceous buffers due to the increased heterogeneity of vegetation structure. But such woody plantings also chiefly host generalist species. For instance, studies in Iowa and Illinois showed that buffers with restored or existing trees hosted generalist birds such as red winged blackbirds, song sparrows *(Melospiza melodia*), and cowbirds (*Molothrus ater*) (Kammin 2003, Schultz et al. 2004).

In the Southeast, and elsewhere in the country, where the native vegetation was dominated by forests, buffers are more frequently planted with trees and shrubs (Table 2). However, most of the knowledge about wildlife response, especially that of birds, has come from general studies of riparian forest buffers in a variety of forest types (Dickson 1989, Haas 1994, Hodges and Krementz 1996, Machtans et al. 1996, Pearson and Manuwal 2001), rather than from practice-specific research. Whereas the presence of trees in riparian buffers in grassland landscapes often has important negative effects, common forest wildlife species are often better adapted to the edge effects of riparian corridors imbedded in forested landscapes. Often the diversity of birds is greater along forest corridors because of the interspersion of deciduous and evergreen species (Darveau et al. 1995, Dickson 1989, Hodges and Krementz 1996, Kilgo et al. 1998). As is the case with herbaceous riparian zones, wider forest buffers host more diverse and productive populations of birds and other wildlife (Hagar 1999, Hodges and Krementz 1996, Kilgo et al. 1998, Pearson and Manuwal 2001, Spackman and Hughes 1995, Rudolph and Dickson 1990, Semlitsch and Brodie 2003). Forest riparian buffers are used as movement corridors by birds, reptiles and amphibians, and presumably by small mammals (Burbrink et al. 1998, Haas 1994, Machtans et al. 1996).

When riparian forest practices are applied in the open grass or along croplands in the Midwest, tree and shrub buffers create "hard edges" so that edge effects are often more pronounced than with herbaceous practices. Some species such as regal fritillaries (*Speyeria idalia*), bobolinks (*Dolichonyx oryzivorous*), dickcissels (*Spiza americana*), and red-winged blackbirds (*Agelaius phoeniceus*) also demonstrate behavioral avoidance of wooded edges (Ries and Debinski 2001, Fletcher and Koford 2003, Henningsen 2003). In a study in Iowa, bobolink density was lower near wooded edges than other types of edges (road or crop), and breeding birds avoided placing territories near woody edges (Fletcher and Koford 2003). In addition to causing behavioral effects, woody edges can be a detriment to reproductive success. Winter et al. (2000) studied the effect of forested, shrubby, road, and agricultural field edges on artificial nests, and on real nests of dickcissels and Henslow's sparrows (*Ammodramus henslowii*). Artificial nest survival was depressed within 30 m (98 ft) of woodland edges, and real nests suffered greater predation within 50 m (164 ft) of shrubby edges than at greater distances.

In northern areas, plantings that include trees and shrubs have special value during winter, providing both cover from severe weather and predators. For instance, when snow is deep, herbaceous buffers often act as drift fences that catch snow, but the presence of shrubs and trees provides additional structure that provides wildlife habitat value (Gabbert et al. 1999).

Riparian

CP22—Riparian Forest Buffer

Riparian forest buffers are plantings consisting of three zones – an unmanaged woody zone adjacent to the water body, a managed zone of woody vegetation, and a zone of herbaceous vegetation (grasses and sometimes forbs) adjacent to the cultivated field. Riparian forest buffer benefits are particularly focused on water quality, although they have important consequences as wildlife habitat. They are designed to reduce scour erosion on stream banks and reduce sediment and contaminant loads in surface runoff. They are also intended to create more favorable habitat for aquatic species by providing shade, lowering water temperatures, and creating a source of coarse woody debris.

Plant species diversity and associated structural heterogeneity provide a variety of perching and nesting sites for birds and lead to a greater variety of microhabitats for invertebrates and small mammals. In general, diverse vegetation structure and composition benefit a greater variety of wildlife, so the additional vertical structure provided in a riparian forest buffer should provide habitat for a greater number of species than an herbaceous strip. However, in landscapes that were traditionally dominated by prairies and wetlands, the native wildlife may not be well adapted to the artificial introduction of trees (Naugle et al. 1999). Trees and shrubs provide perching sites for avian predators and species like cowbirds that parasitize nests of grassland birds. Large trees provide den sites for mammalian predators. Woody edges are associated with greater predation rates on nests (Winter et al. 2000) and some species exhibit an aversion to nesting near a woody edge (Henningsen 2003).

In landscapes where cover is limiting, wooded riparian corridors provide important habitat and travel corridors for large mammals (Hilty and Merenlender 2004), such as white-tailed deer (*Odocoileus virginianus*) and larger predators such as red fox (*Vulpes vulpes*).

Information on how the width of riparian forest buffer plantings affects wildlife is lacking, but can be inferred from research on similar systems. For example, Keller et al. (1993) found that probabilities of occurrence of birds in riparian forests were positively associated with width, with the greatest increases occurring between 25 and 100 m.

A thorough understanding of how landscape context influences wildlife in riparian forest buffers is lacking. Research on riparian forests and riparian forest buffers in Missouri shows that they provide habitat for area-sensitive forest and grassland-shrub nesting species (Peak et al. 2004). However, nest success was lower than that needed to balance mortality, and the authors indicated that in predominantly agricultural areas, even wide riparian forest buffers (400-530 m) have limited potential to serve as high-quality breeding habitat for some forest bird species. Landscape context is thus an important consideration and as yet not fully understood.

In-field

CP5—Field Windbreak, CP16—Shelterbelt, CP17—Living Snow Fence

A windbreak is a strip of trees or shrubs planted in a field to reduce wind-caused soil erosion, conserve moisture, and protect crops and/or livestock. A shelterbelt is a type of windbreak that is used around buildings to provide a barrier against chemical drift (from hog confinements, for instance) or to protect a farmstead from wind, preserving energy and protecting livestock and plants. Living snow fences are windbreaks that are placed by roads in order to control snow deposition. Windbreaks came into wide use after the Dust Bowl of the 1930s as a way of reducing the soil erosion that resulted from the transformation of the plains into a cultivated and grazed landscape. In Great Plains states where trees are scarce and naturally occur primarily along streams, windbreaks and shelterbelts make up a significant proportion of woody habitat. In Nebraska, for instance, which is less than 2 percent wooded, windbreaks make up 25 percent of the woody cover (Soil Conservation Service 1989). The bulk of the available research on wildlife response to these practices is centered on field windbreaks.

Living snow fence designed to control snow deposition. (Photo courtesy of USDA NRCS)

As with other linear practices, windbreaks are often small features on the landscape, thus influencing wildlife habitat quality. For example, Hess and Bay (2000) used a habitat suitability index (0-1 scale) created by the U.S. Fish and Wildlife Service to assess the value of Nebraska windbreaks for wildlife, including birds, small mammals, and deer. They found that 50 percent of windbreaks had a suitability of 0.25 or lower, and no windbreaks rated above a 0.6. They suggested that expanding the size of individual windbreaks will increase habitat suitability for such species.

Not only do windbreaks, shelterbelts, and fencerows attract birds and small mammals, they also provide habitat for mammalian predators and raptors. While the presence of these predators may cause direct mortality to birds such as pheasants, or limit their nesting success, the predators themselves are valuable additions to the diversity of wildlife on the agricultural landscape.

An indirect effect on wildlife that is easily overlooked is the influence of windbreaks and shelterbelts on wind speed, which is particularly important to flying insects. Windbreaks and shelterbelts have a measurable impact on arthropod communities that function both as pests and prey in cropping systems and food for other wildlife (Bhar and Fahrig 1998, Dix et al. 1995). As width is increased and plantings are diversified, more microclimate conditions are created and insect communities are larger and more diverse (Pasek 1988). Woody vegetation within buffers and field borders may serve as a refuge for insect pests and beneficial predators and also inhibit movement of crop pests (Bhar and Fahrig 1998, Dix et al. 1995).

Conclusion

Linear practices were primarily designed to be efficient at reducing water flow, trapping sediment, and filtering harmful substances associated with wind and water erosion before they reach streams and lakes. Buffers are useful in terms of soil and water conservation and certainly provide wildlife habitat improvements over crop fields, but they have limitations that are associated with the small size and isolated nature of most practices. Recent research has provided some direction about how to maximize the benefits of linear practice buffers to wildlife (Table 3). Positive effects are associated with longer and wider buffers, buffers associated with or connecting other habitat practices such as blocks of cover or food plots, and with practices that are grouped on the landscape.

From a wildlife conservation standpoint, even well-managed, strategically placed linear practices cannot replace the established benefits of the 28 million acres of CRP contracts slated to expire before 2010 (FSA 2004). But better understanding of how landscape context affects the value of linear practices for wildlife will provide some future alternatives for agricultural conservation policy. The recently available Conservation Security Program (CSP) takes a

Table 3. Information sources for linear conservation practices and often-cited benefits and concerns relevant to wildlife.

Practice	Information Available	Benefits/Concerns
CP21 Grass Filter Strip	Murray 2002, Henningsen & Best 2005, Kammin 2003, Reeder et al. 2005	Hosts small mammals, arthropods, birds, but few specialists
CP22 Riparian Forest Buffer	Peak et al. 2004, Henningsen & Best 2005	Provides habitat for greater variety of birds than herbaceous plantings, but nest success low for some species
CP8 Grassed Waterway	Bryan & Best 1991 & 1994, Knoot 2004	Provides perennial cover, but few species, high predation rates on birds, too small for area-sensitive species
CP15 Contour Grass Strip		
Terrace	Hultquist 1999, Hultquist & Best 2001	Bird abundance higher than row crops but lower than other buffers, few nesting species, high predation rates
CP24 Cross Wind Trap Strip		
CP5 Field Windbreak	Hess & Bay 2000, Brandle et al. 2004	Provides physical structure/shelter, but too small for area-sensitive species
CP16 Shelterbelt		
CP17 Living Snow Fence		
CP33 Field Borders (Upland Bird Habitat Buffer)	Smith et al. 2005b	

watershed-level approach, including incentives for agreements between neighbors partnering to achieve a common conservation goal (NRCS 2005). Conservation Reserve Enhancement Program (CREP) projects are using Geographic Information System (GIS) data to inform choices about target locations for conservation practices. Linear practices have a potentially important value in providing flexibility while implementing this extensive view of conservation on agricultural landscapes. ■

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