Grassland Establishment for Wildlife Conservation

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ABSTRACT Establishing grasslands has important implications for wildlife, especially in areas historically rich in grasslands that have since been converted to row crop agriculture. Most grasslands established under farm conservation programs have replaced annual crops with perennial cover that provides year-round resources for wildlife. This change in land use has had a huge influence on grassland bird populations; little is known about its impacts on other terrestrial wildlife species. Wildlife response to grassland establishment is a multi-scale phenomenon dependent upon vegetation structure and composition within the planting, practice-level factors such as size and shape of the field, and its landscape context, as well as temporal factors such as season and succession. Grassland succession makes management a critical issue. Decisions on how frequently to manage a field depend on many factors, including the location (especially latitude) of the site, the phenology at the site in the particular year, the breeding-bird community associated with the site, and weather and soil conditions. The benefits for a particular species of any management scenario will depend, in part, on the management of surrounding sites, and may benefit additional species but exclude others. Thus, the benefits of grassland establishment and management are location- and species-specific.

Prior to European settlement, prairies and other grasslands covered an estimated 300 million ha (740 million acres) of the United States (Risser 1996) and were the largest vegetation type in North America (Samson and Knopf 1994). Major grassland ecosystems can be classified into six distinct types based on geography and vegetation structure: the tallgrass, mixed-grass, and shortgrass prairies of the central plains, the desert grasslands of the Southwest, the California grasslands, and the Palouse prairie of the Northwest (Risser 1996). Additionally, subtropical grasslands occurred in Florida and the eastern gulf plain of Texas, and smaller grasslands occurred in the eastern United States and intermountain west (Rich et al. 2004).

Grasslands have been termed the nation's most threatened ecosystem (Noss et al. 1995, Samson and Knopf 1994). Although they were unable to attain data for several states, Sampson and Knopf (1994) reported reductions in the U.S. central plains of 82.6 percent to 99.9 percent for tallgrass prairies, 30 percent to 77.1 percent for mixed-grass prairies, and 20 percent to 85.8 percent for shortgrass prairies. Reductions for grassland types in other portions of the country are similar to those of tallgrass prairie, including California grasslands (99 percent) and the Palouse prairie (99.9 percent) (reviewed by Noss et al. 1995). Losses of native grasslands have been (and continue to be) primarily due to conversion to agricultural or suburban land uses, though woody invasion after fire suppression (Rich et al. 2004) and the planting of trees and other non-native plants in the post-dust bowl era also contributed (Samson and Knopf 1994). In addition to quantitative losses, grasslands have been impacted qualitatively by alterations of natural disturbance regimes (fire, grazing pressure, and hydrology) and changes in species composition caused by invasive and non-native species (Rich et al. 2004, Noss et al. 1995, Samson and Knopf 1994).

Concomitant with losses and degradation of grasslands have been declines of wildlife populations. Disappearance of the massive bison (*Bison bison*) herds from the Great Plains is well known, but many other grassland species are endangered, threatened or candidates for listing (e.g. black-footed ferret (*Mustela nigripes*), prairie dog (*Cynomys sp.*), and mountain plover (*Charadrius montanus*)). There are many more species for which we lack good information. Our best national data on wildlife populations exists for birds. Most grassland-nesting birds have been experiencing significant population declines for the 37 years of Breeding Bird Survey monitoring (Sauer et al. 2004), despite the fact that most grassland losses occurred before the survey began (Noss et al. 1995). Research has documented breeding in the Great Plains by 330 of the 435 bird species that breed in the United States (Samson and Knopf 1994), including almost 40 percent of the species on Partners In Flight's continental Watch List (Rich et al. 2004). Additionally, U.S. grasslands are important wintering habitat for birds of the Northern Forest Avifaunal Biome, which stretches from the northeastern United States northwest across Canada, as well as grassland breeding birds (Rich et al. 2004).

The Conservation Reserve Program (CRP) has played an important role in stemming the losses of U.S. grasslands. Beginning as part of the Food Security Act of 1985 (a.k.a. the 1985 Farm Bill), the CRP retired highly erodible cropland for a period of 10 years. Producers received rental and incentive payments to plant perennial vegetation. Most (>75 percent) of the 14 million ha (34.8 million acres) enrolled in CRP has been planted to grass or a mixture of grasses and forbs or legumes (Table 1). New grass plantings in the continental United States have been established in areas that were historically grassland (Figures 1-4). Although many conservation practices (CP) may incorporate grass (e.g., permanent wildlife habitat, CP4), seven exclusively establish grass or grass-based herbaceous mixtures: new introduced grasses and legumes (CP1), new native grasses (CP2), grass waterways (CP8), existing grasses and legumes (CP10), filter strips (CP13 and CP21), contour grass strips (CP15), and cross wind trap strips (CP24).

This manuscript discusses the impact of grass field establishment and management on wildlife species. We focus on CRP, specifically CP1 and CP2, because this program is the primary vehicle for establishment of grass fields and has been the focus of most of the research into the wildlife impacts of farm conservation practices. Our discussions are valid for CP10 as these acres are primarily re-enrollments of CP1 and CP2 fields. Most research has been conducted on avian communities in the Great Plains, Midwest, and Southeast. Thus, our discussion of benefits to wildlife necessarily concentrates on birds; we discuss other

information where available. Discussion of the benefits of other grass-based establishment practices can be found in the chapter on linear strips and conservation buffers. Although the management and spatial context issues discussed here are equally pertinent to conservation of rangelands, please see the rangeland chapter for a detailed treatment.

Desired Fish and Wildlife Benefits

Wildlife conservation was a secondary consideration of the 1985 Farm Bill but was elevated to co-equal status with erosion and water quality concerns with the 1996 re-authorization. Still, it was widely assumed that the establishment of CRP plantings would positively affect grassland wildlife populations (e.g., Berner 1988), by providing perennial food and cover resources. In their review of the literature, Ryan et al. (1998) listed 92 species of birds observed using CRP grass plantings in the central United States during spring and summer (i.e., the breeding season), including at least 42 species nesting in CRP. Recent research has added only one species to that list; Evard (2000) noted three rough-legged hawks (*Buteo lagopus*) hunting CRP fields in Wisconsin. Best et al. (1998) recorded 40 species using CRP fields in the Midwest during winter, five of which do not use the fields during the breeding season. Mammals, reptiles, and invertebrates also have been shown to use CRP grass plantings (reviewed by Farrand and Ryan 2005). The benefits provided by planting grass fields can be measured, in part, by the response of wildlife species to the grass relative to the crop land they replaced. Such benefits are related, in part, to the vegetation composition and structure of the plantings and how these factors change naturally over time (i.e., succession).

Retiring Cropland

Replacing annual crops with perennial grasses has the potential to provide stable cover and food resources for wildlife. Indeed, avian studies have shown higher abundances or densities of birds in CRP grass fields than in the crop lands they replaced. King and Savidge (1995) reported avian abundance to be four times greater in CRP fields than crop fields in Nebraska. Analogously, in southeastern Wyoming, Wachob (1997) found higher densities of grassland birds in CRP fields (as well as in native rangeland) than in croplands. In the Midwest, Best et al. (1997) detected from 1.4 to 10.5 times more birds in CRP grass fields than rowcrop fields during the breeding season. Interestingly, the total number of bird species observed in CRP plantings by Best et al. (1997, 1998) did not differ markedly from the number of species they observed in nearby rowcrop fields. However, 16 species of birds were unique or substantially more abundant in CRP fields than in nearby rowcrop fields. Three of the four bird species they frequently observed in CRP (dickcissel [*Spiza americana*], grasshopper sparrows [*Ammodramus savannarum*], and bobolinks [*Dolichonyx oryzivorus*]) have been undergoing significant population declines. Additionally, Henslow's sparrow (*Ammodramus henslowii*) and sedge wren (*Cistothorus platensis*), species of high conservation concern in the Midwest (Herkert et al. 1996), occurred only in CRP fields. The Henslow's sparrow also is listed as a continental Watch List species (Rich et al. 2004). Of the five species unique or substantially more abundant in rowcrops than in CRP fields (Best et al. 1997), only one, the lark sparrow (*Chondestes grammacus*), is of moderate conservation concern in the Midwest (Herkert et al. 1996). Summer observations of ring-necked pheasants (*Phasianus colchicus*) in western Kansas, analyzed by Rodgers (1999), showed they used CRP fields more than their availability in northwestern Kansas but not in southwestern Kansas, where shorter grass plantings may not provide better habitat than cropland. Pheasant indices in Wisconsin CRP fields were 10-fold higher than in surrounding private farmland (Evard 2000). Johnson and Igl (1995) projected declines in the populations of 15 grassland bird species breeding in North Dakota CRP if those grass fields were reverted back to cropland.

Greater benefits are accrued to those species that breed successfully in planted grass fields than to those that simply use the fields for food or cover (Ryan 2000), because the breeding season is the part of the annual cycle that most strongly influences the population size of birds. Assessing the reproductive rate is much more challenging than determining population size; grassland birds are notoriously secretive in their breeding habits. Such behavior is

Table 1. Summary of grass area and total area in the Conservation Reserve Program by state and the proportion of area in Conservation Practices that establish whole-field grass-based plantings. Numbers presented here reflect conditions as of March 2005.

State[a]	Grass (ha)	Total (ha)	%Grass	%CP1[b]	%CP2[b]	%CP10[b]
Alabama	50,949	196,783	25.9	4.0	2.9	92.2
Alaska	11,858	12,066	98.3	19.6	0.0	80.4
Arkansas	15,707	81,813	19.2	7.8	8.0	70.3
California	54,322	58,940	92.2	3.9	1.2	94.9
Colorado	818,246	926,006	88.4	2.4	29.7	67.8
Connecticut	103	129	80.2	27.5	13.3	51.4
Delaware	610	3,134	19.5	3.5	1.5	2.0
Florida	1,019	35,213	2.9	11.8	6.0	82.0
Georgia	3,911	123,457	3.2	5.9	4.0	75.9
Idaho	259,855	319,949	81.2	14.0	3.1	82.7
Illinois	262,128	413,485	63.4	27.7	6.1	38.8
Indiana	91,508	116,681	78.4	16.9	12.6	38.7
Iowa	537,793	773,352	69.5	22.3	11.0	44.2
Kansas	1,046,509	1,161,142	90.1	0.7	31.0	66.8
Kentucky	122,732	136,421	90.0	29.1	12.6	46.1
Louisiana	8,629	98,505	8.8	0.7	11.4	84.8
Maine	8,588	9,436	91.0	6.1	0.5	92.7
Maryland	24,348	34,178	71.2	19.6	5.9	6.9
Massachusetts	47	49	95.9	0.0	0.0	45.7
Michigan	79,886	105,749	75.5	17.3	9.5	51.4
Minnesota	338,672	713,815	47.4	29.3	16.1	35.4
Mississippi	58,624	380,740	15.4	4.0	0.3	90.1
Missouri	574,829	627,322	91.6	25.9	12.9	58.0
Montana	1,234,173	1,376,732	89.6	23.1	27.2	49.7
Nebraska	408,382	483,350	84.5	4.6	35.5	57.6
New Hampshire	70	80	87.8	5.8	0.0	0.0
New Jersey	859	926	92.8	53.5	17.2	21.8
New Mexico	238,503	241,337	98.8	0.2	30.9	68.8
New York	18,589	24,613	75.5	12.8	1.7	84.0
North Carolina	11,735	50,064	23.4	7.8	5.7	62.2
North Dakota	753,405	1,351,363	55.8	21.9	3.5	74.1
Ohio	83,891	112,834	74.3	12.3	13.9	46.5
Oklahoma	407,143	417,669	97.5	1.9	39.0	58.9
Oregon	187,974	204,956	91.7	23.8	11.4	64.2
Pennsylvania	68,800	76,587	89.8	48.3	16.3	33.9
Puerto Rico	186	448	41.5	23.5	0.0	76.5
South Carolina	7,421	85,600	8.7	3.7	0.6	60.9
South Dakota	367,173	593,500	61.9	18.3	25.2	55.6
Tennessee	89,485	110,653	80.9	14.3	18.7	62.6
Texas	1,565,462	1,602,024	97.7	2.8	42.2	54.8
Utah	81,314	81,732	99.5	28.7	7.4	63.8
Vermont	105	626	16.8	0.0	0.0	44.6
Virginia	9,919	25,338	39.1	17.1	11.1	54.8
Washington	478,310	563,134	84.9	10.6	49.2	33.1
West Virginia	299	1,062	28.1	1.4	3.0	89.0
Wisconsin	188,804	251,179	75.2	10.2	12.0	71.8
Wyoming	100,690	113,755	88.5	22.9	3.0	74.1
Undesignated	13	91	14.7	0.0	100.0	0.0
Total (ha)	10,673,588	14,098,018	75.7	13.1	24.8	57.6
Total (ac)	26,363,762	34,822,105				

[a]States and territories with CRP enrollments. Arizona, Hawaii, Nevada, and Rhode Island did not have enrollments.
[b]Conservation Practices that establish whole-field grass-based plantings are: CP1 – new introduced grasses and legumes; CP2 – new native grasses; and CP10 – existing grasses and legumes.

Figure 1. Land in active CRP contracts in the U.S. and Puerto Rico as of 30 April 2005 for new introduced grasses and legumes (CP1). Disclosure indicates data unavailable due to privacy restrictions required by the Farm Security and Rural Investment Act of 2002.

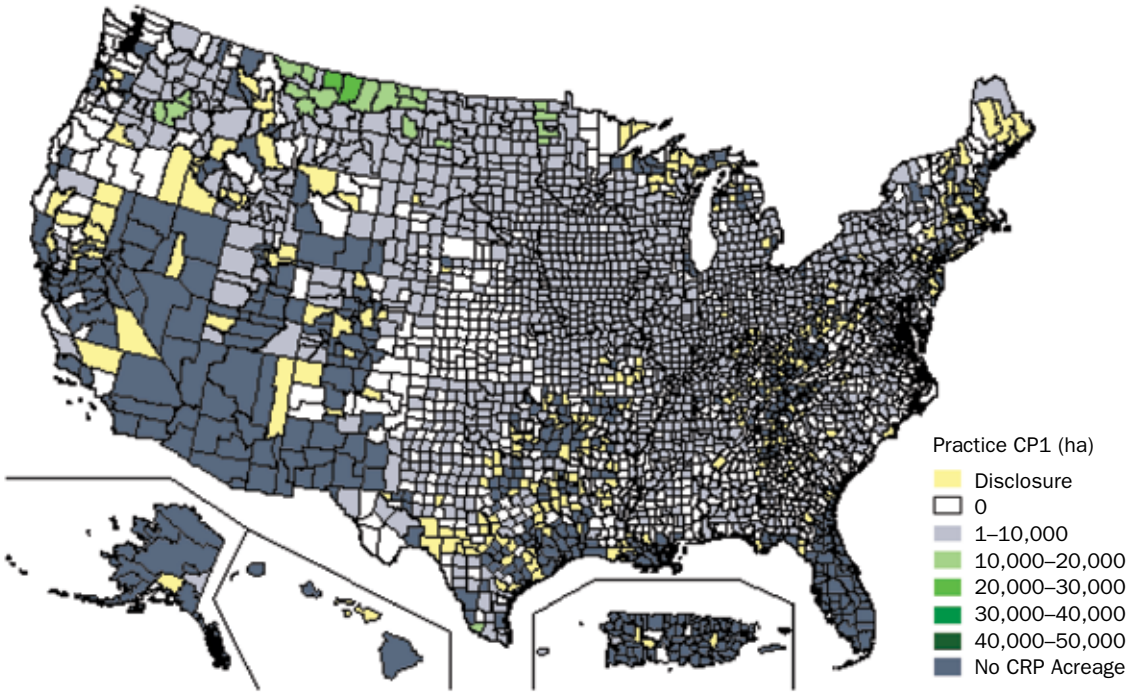


Figure 2. Land in active CRP contracts in the U.S. and Puerto Rico as of 30 April 2005 for new native grasses (CP2). Disclosure indicates data unavailable due to privacy restrictions required by the Farm Security and Rural Investment Act of 2002.

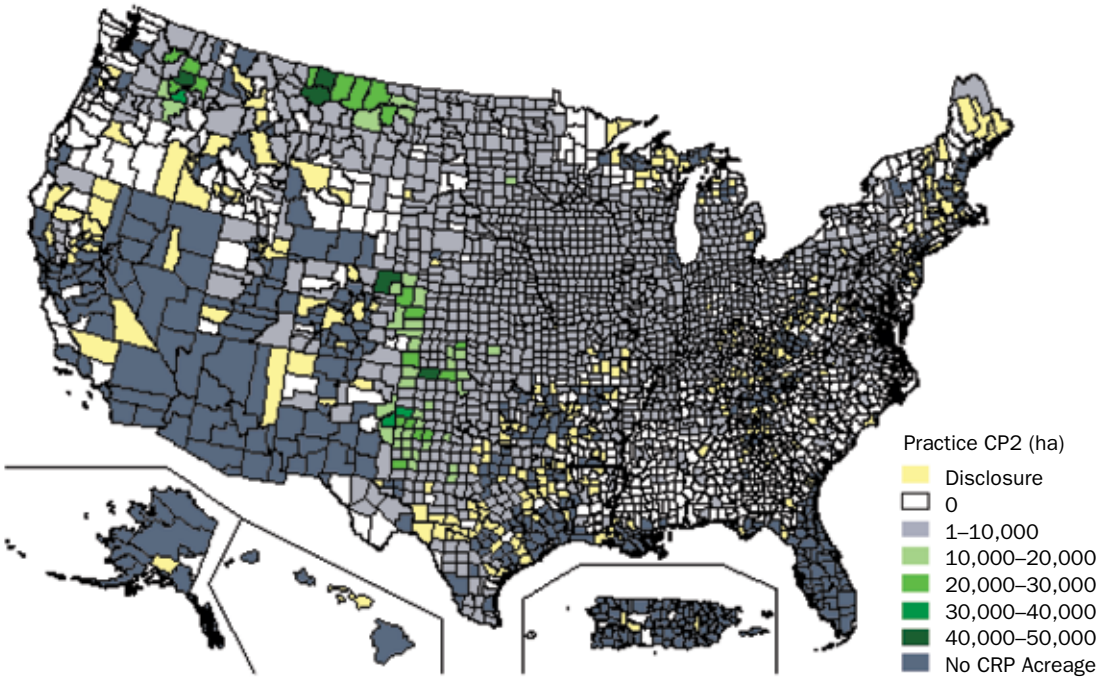


Figure 3. Proportion of active CRP contracts in new introduced grasses and legumes (CP1) for the U.S. and Puerto Rico as of 30 April 2005. Disclosure indicates data unavailable due to privacy restrictions required by the Farm Security and Rural Investment Act of 2002.

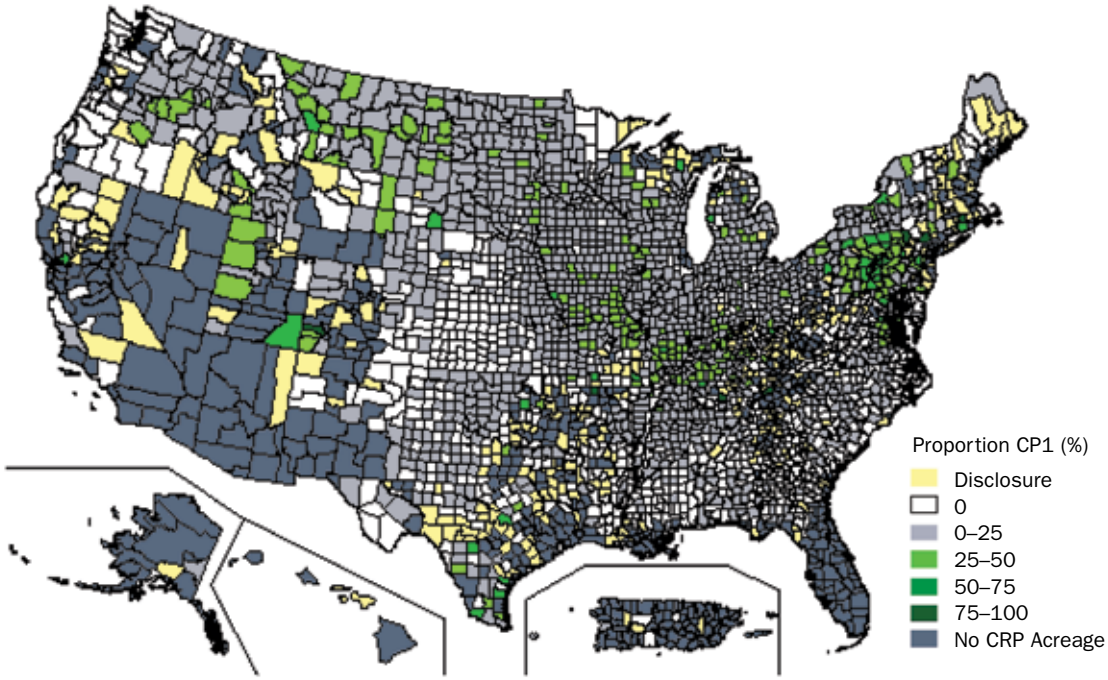
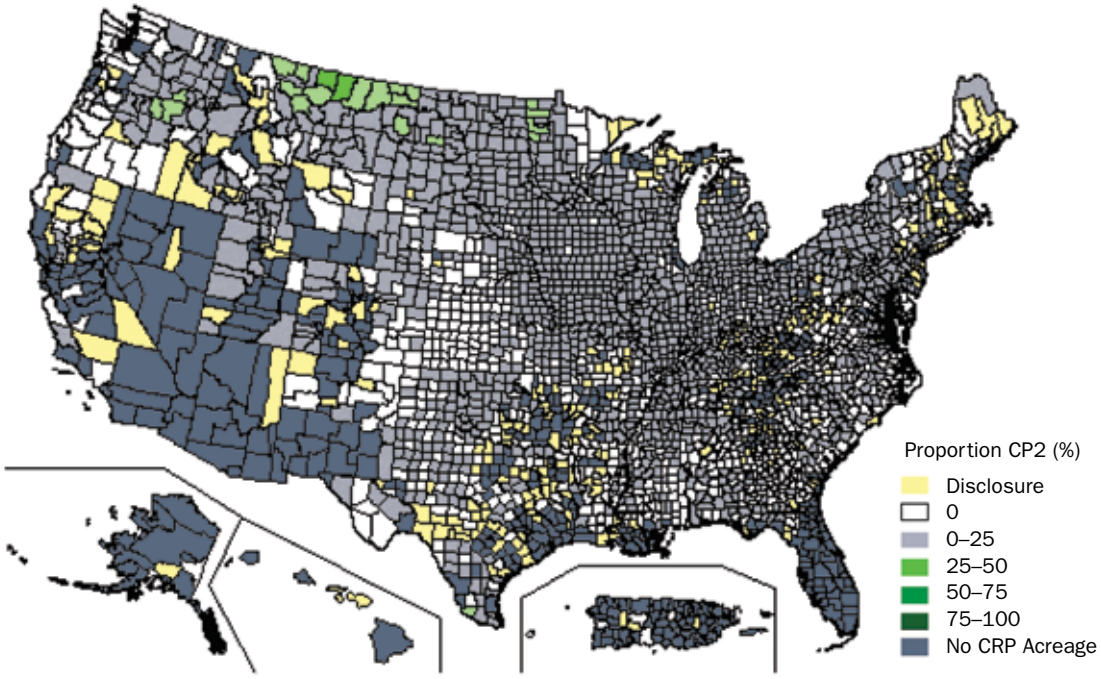


Figure 4. Proportion of active CRP contracts in new native grasses (CP2) for the U.S. and Puerto Rico as of 30 April 2005. Disclosure indicates data unavailable due to privacy restrictions required by the Farm Security and Rural Investment Act of 2002.



necessary to avoid drawing the attention of a wide range of species that depredate nests in grasslands. Avian reproductive success has not been well studied in CRP fields in the Great Plains, but the studies that have been conducted indicate that birds, including several grassland species of conservation concern, are at least as successful in CRP fields as in other land cover types. In northwest Texas, Berthelsen et al. (1990) found approximately six pheasant nests per 10 acres of CRP grassland, but no nests in cornfields. Berthelsen and Smith (1995) found a number of nongame bird nests incidental to their upland gamebird study in Texas. Most common species recorded were red-winged blackbirds (*Agelaius phoeniceus*), grasshopper sparrows, Cassin's sparrows (*Aimophila cassinii*), and western meadowlarks (*Sturnella neglecta*). Nest success values were higher than those typically reported in other studies in the agricultural Midwest. Koford (1999) found nests of red-winged blackbirds, grasshopper sparrows, and savannah sparrows to be most common in CRP fields in his North Dakota study sites, while in Minnesota sites the most numerous species were red-winged blackbirds, bobolinks, grasshopper sparrows, and savannah sparrows (*Passerculus sandwichensis*). He found fledging success of ground-nesting birds in CRP fields was lower than on Waterfowl Production Area plantings, but not significantly so.

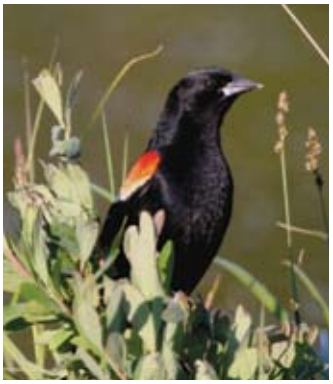
In the Midwest, CRP plantings have been extensively used for nesting by grassland birds. Murray and Best (2003) found 20 species nesting in switchgrass (*Panicum virgatum*) CRP fields in 1999 and 2000 in Iowa; red-winged blackbirds comprised 56 percent of the sample. Best et al. (1997) located 1,638 nests of 33 bird species in CRP fields versus only 114 nests of 10 species in a similar area of rowcrops. In rowcrop, they most frequently discovered red-winged blackbird, vesper sparrow (*Pooecetes gramineus*), and horned lark (*Eremophila alpestris*) nests. Nests of red-winged blackbirds, dickcissels, and grasshopper sparrows were the most frequently located in CRP fields by Best et al. (1997). Similar lists of species nesting in CRP have been produced by recent studies (Davison and Bollinger 2000, McCoy et al. 2001a). House sparrow (*Passer domesticus*) was the most common avian species nesting in CRP fields in northeast Kansas (Hughes et al. 2000). CRP also appears to be important nesting habitat for mourning doves (*Zenaida macroura*) in Kansas (Hughes et al. 2000). In Wisconsin, ring-necked pheasant, gray partridge (*Perdix perdix*), northern harrier (*Circus cyaneus*), short-eared owl (*Asio flammeus*), and duck nests have been reported (Evard 2000). In Missouri, 55 percent of northern bobwhite (*Colinus virginianus*) nests and 46 percent of brood-foraging locations occurred in CRP fields that comprised only 15 percent of the largely agricultural landscape (Burger et al. 1994).

Grass fields also provide important resources for birds in winter. Although Morris (2000) reported higher species richness in crop fields in southern Wisconsin, she reported lower abundances in crop fields than CP2 fields. Avian abundance in crop fields was higher during periods of incomplete snow cover than during periods with 100 percent snow cover, while the reverse was true for CP2 sites. Morris (2000) did not observe if grassland birds were using CP1. However, total bird use in winter did not differ between introduced grasses with legumes (CP1) and switchgrass monocultures (CP2) in Missouri (McCoy et al. 2001a). During the winter months, ring-necked pheasants, northern bobwhites, American tree sparrows (*Spizella arborea*), dark-eyed juncoes (*Junco hyemalis*), and American goldfinches (*Carduelis tristis*) were the most abundant or widely distributed species observed in CRP fields (Best et al. 1998). All but the goldfinch have been undergoing long-term population declines (Sauer et al. 1996). King and Savidge (1995) reported use in Nebraska by American tree sparrows, ring-necked pheasants, red-winged blackbirds, western meadowlarks, horned larks, and northern bobwhites. Delisle and Savidge (1997) noted only American tree sparrows, ring-necked pheasants, and meadowlarks (*Sturnella sp.*) (eastern and western meadowlarks were not distinguishable) wintering on their Nebraska study areas. Burger et al. (1994) provided evidence that CRP plantings in Missouri provided important winter cover for northern bobwhites. They documented that 69 percent of nighttime roosts occurred in CRP fields in an area where CRP made up only 15 percent of the landscape. Rodgers (1999) used counts of droppings to compare winter pheasant use of weedy wheat stubble and CRP in north central Kansas. Despite offering comparable concealment, dropping density was 2.75 times greater in wheat stubble than CRP. Dropping data suggested that pheasants were using CRP for night-time roost-

ing. CRP may be less valuable to pheasants in winter due to fewer food sources, excessive litter, and the less rigid stems of the planted grass.

Information comparing mammalian use of planted grass fields with crop fields is scarce, and information on reproductive activity is virtually non-existent. Olsen and Brewer (2003) reported that a three-year, winter wheat (*Triticum aestivum*) rotation in southeastern Wyoming had higher rodent abundance and diversity than CRP at both sites in both years studied. A study of white-tailed deer (*Odocoileus virginianus*) habitat use in South Dakota revealed that CRP fields were used proportionately greater than habitat availability during periods of deer activity during spring, and during evening and midnight periods during summer (Gould and Jenkins 1993). Increased use of CRP between spring and summer corresponded with rapid vegetation growth and fawning. Similarly, white-tailed deer in southeastern Montana used CRP in greater proportion than its availability in all seasons except fall (Selting and Irby 1997). Indirect evidence of mammalian use of CRP comes from the nest predation literature. Hughes et al. (2000) listed potential nest predators at their sites in Kansas, including coyotes (*Canis latrans*), raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), opossums (*Didelphis virginiatum*), feral cats (*Felis domesticus*), and badgers (*Taxidea taxus*). Evard (2000) attributed duck nest predation to mammalian predators, including red fox (*Vulpes vulpes*), striped skunk, and raccoon, though hard evidence was lacking. Other mammalian species incidentally noted in CRP included white-tailed jackrabbits (*Lepus townsendii*), white-tailed deer fawns, and a coyote den with three pups (Evard 2000).

Dickcissel. (Photo by S. Maslowski, USFWS)



Red-winged Blackbird. (Photo by D. Dewhurst, USFWS)

As with mammals, information on benefits accrued to other groups of wildlife is rare. Burger et al. (1993) reported mean invertebrate abundance and biomass in CRP fields were four times higher than in soybean fields. Phillips et al. (1991) detected a low incidence of cotton pests and found beneficial predator species in Texas CRP. Davison and Bollinger (2000) identified four species of snakes common on their study sites in east-central Illinois, including prairie kingsnake (*Lampropeltis calligaster*), common garter snake (*Thamnophis sirtalis*), black rat snake (*Elaphe obsoleta obsoleta*), and blue racer (*Coluber constrictor*). Hughes et al. (2000) listed bullsnakes (*Pituophis melanoleucus*) as a potential nest predator in Kansas CRP.

Planting Perennial Vegetation

Wildlife response to changes in land use is species-specific, depending on life-history requirements. Thus, issues regarding the composition of the planting (e.g., introduced or native species, monoculture of grass or a mixture of grasses and forbs/legumes, seeding rate, etc.) and its resultant structure (e.g., height, plant density) will play an important role in determining what species can benefit from the practice.

The primary farm conservation practices that establish new grass fields are CP1 (introduced grasses and legumes) and CP2 (native grasses). As the names suggest, the primary difference between the two is the origin of grass and legume seed. Either practice can be planted as a grass monoculture or as a mixture of grasses with or without forbs and/or legumes; eligible plant lists are developed by individual states. Each planting must conform to NRCS Practice Standard 327 – Conservation Cover (NRCS 2002). The standard sets forth base criterion for each establishment including: minimum seeding rates; guidelines for the seeding rate, seedbed preparation, and companion crops; and management considerations. The standard also includes "Additional Criteria for Enhancement of Wildlife Habitat," which gives guidelines related to plant selection, native forb establishment, an adjustment factor (0.75) to reduce seeding rates if erosion control guidelines can still be met, and maintenance recommendations. The combination of the practice standard with the individual land owner's conservation plan yields flexibility to meet the land owner's needs and variability in the practice's wildlife habitat value.

Few studies have directly compared avian response to CP1 and CP2 plantings. McCoy et al. (2001a) found that species richness, abundance and nesting success of grassland birds during the breed-

ing season did not differ between CP1 (introduced grasses and legumes) and CP2 (switchgrass monocultures) in Missouri. However, species-specific Mayfield nest success often differed between CP1 and CP2 within years, and the better type switched between years in several cases. However, means differed only for red-winged blackbird. Parasitism rates did not differ between the practices for any species, but varied with host species (mean=18%, range 0-40%). Fecundity of dickcissel, a continental Watch List species (Rich et al. 2004), and nesting success and fecundity of red-winged blackbirds were higher on CP2 than on CP1 habitat, but both practices were likely sinks ($\lambda < 1$) for these species. For grasshopper sparrows, a species of national concern (Rich et al. 2004), nest success was 49 percent in CP2 compared with 42 percent in CP1. Both practices were likely source ($\lambda > 1$) habitat for grasshopper sparrows, whereas only CP1 fields were likely a source for eastern meadowlarks (*Sturnella magna*) and American goldfinches (McCoy et al. 2001a).

Morris (2000) compared winter use by grassland birds of CRP, crop fields, pastures, and restored and native prairies in southern Wisconsin. In this study, species diversity was highest in crop fields, followed by restored prairie, CP2 fields (a mixture of native warm-season grasses and two forbs), native prairie remnants, and pastures, while avian abundance was highest in pastures, followed by restored prairie, CP2, crop fields, and native prairie. No species were observed using CP1 fields (a mixture of introduced grasses and legumes) in this study. In contrast, McCoy et al. (2001a) found that total bird use in the winter did not differ between CP1 and CP2 in Missouri.

Although we know of no studies directly examining mammalian response to CP1 versus CP2, two studies have compared CP1 fields to native prairies. Hall and Willig (1994) found that CP1 fields simulated shortgrass prairies of northwest Texas in small mammal diversity but not in species composition, suggesting that CRP was not mimicking natural conditions. Of the 11 species captured in the study, only the southern plains woodrat (*Neotoma micropus*) was not captured on CRP. Also in northwest Texas, Kamler et al. (2003) reported that both adult and juvenile swift fox (*Vulpes velox*) strongly avoided CP1 fields. Whereas CRP comprised 13 percent of the available habitat for adults and 15 percent of the available habitat for juveniles, only 1 of 1,204 locations was recorded in a CRP field. The authors believed this was due to the taller, denser vegetation of CP1 (introduced warm-season grass plantings) compared with the native short grass prairie preferred by swift foxes.

Several studies have focused on invertebrate response to CP1 and CP2 plantings. Burger et al. (1993) reported that CP1 fields planted to timothy (*Phleum pretense*) and red clover (*Trifolium pretense*) had significantly higher invertebrate abundance and biomass than CP1 or CP2 grass monocultures or CP1 fields planted orchard grass (*Dactylis glomerata*) and Korean lespedeza (*Kummerowia stipulacea*). Carroll et al. (1993) determined CRP grasses (native and exotic) to be marginal over-wintering habitat for boll weevils (*Coleoptera: curculionidae*) in Texas. Also in Texas, McIntyre and Thompson (2003) reported that CP1 and CP2 fields had less vegetative diversity and lower arthropod diversity than native shortgrass prairie, but did support avian prey groups. The CRP types were similar in terms of invertebrate abundances (i.e., no support that different types of grasses possess different prey availabilities for grassland birds). In a concurrent study, McIntyre (2003) surveyed CP1, CP2 and native shortgrass prairie in the Texas panhandle for endangered Texas horned lizards (*Phrynosoma cornutum*) and their food supply, harvester ants (*Pogonomyrmex*). Ant nest densities varied within the classes but not between, suggesting that planting type (exotic vs. native) did not affect habitat value. Lizards also were seen on both types of CRP, but only at sites with ant nests.

Several studies investigated the effect of forb abundance on wildlife response. Hull et al. (1996) examined the relationship between avian abundance and forb abundance in native-grass CRP fields in northeast Kansas. The expected significant relationship was not found, but no field had > 24 percent forbs, which the authors surmised was too low to produce a response. Their data also did not support the hypothesis that invertebrate biomass was correlated positively with forb abundance. However, Burger et al. (1993) concluded that planting legumes may improve CRP plantings for northern bobwhite brood-rearing habitat due to increased invertebrate biomass. Swanson et al. (1999) reported that savannah sparrows used fields with less forb canopy cover.

Vegetation Succession

Although the initial planting mixture and density is important, changes in structure will occur over time. McCoy et al. (2001b) studied vegetation changes on 154 CRP grasslands in northern Missouri and reported that during the first two years following establishment, fields are characterized by annual weed communities with abundant bare ground and little litter accumulation. Within three to four years, CRP fields became dominated by perennial grasses with substantial litter accumulation and little bare ground. They suggested that vegetation conditions three to four years after establishment might limit the value of enrolled lands for many wildlife species and some form of disturbance, such as prescribed fire or disking, might be required to maintain the wildlife habitat value of CRP grasslands.

Few studies have examined avian response to field age. In an analysis of Breeding Bird Survey data combined with CRP contract data, Riffell and Burger (2006) showed the abundances of northern bobwhite and common yellowthroat were positively correlated with the density of CRP fields <4 years old. Eggebo et al. (2003) observed more crowing pheasants in old, cool-season, CRP fields than any other age or cover type in South Dakota. Delisle and Savidge (1997) noted that grasshopper sparrow densities declined in the CRP fields in Nebraska each year of their study from 1991 to 1994. They attributed that change to a build-up of litter and dead vegetation. Swanson et al. (1999) evaluated avian use of two- to seven-year-old CRP (CP1, CP2 and CP10) fields in Ohio and reported that neither species richness nor total abundance was related to field age. However, these coarse summary metrics may mask shifts in community composition (Nuttle et al. 2003).

As with birds, little information exists on mammalian response to aging fields. Furrow (1994) captured eight small mammal species on CRP fields planted to exotic grasses (CP1) in Michigan. Deer and white-footed mice (*Peromyscus spp.*) dominated younger fields and meadow voles (*Microtus pennsylvanicus*) dominated older (>2 years) fields. *Peromyscus* numbers were positively correlated with bare ground and forb canopy cover, and voles were positively correlated with litter depth. Fields <2-years-old had a greater diversity of small mammalian species than older fields, while relative abundance increased with age. Millenbah (1993) reported greater insect abundance on one- to two-year-old fields, which may have contributed to greater small mammal diversity on these age classes. Conversely, Hall and Willig (1994) detected no significant differences in mammalian diversity due to age of CP1 plantings. However, their sites were only one to three years post-planting compared with Furrow's one- to six-year-old sites. Furrow (1994) also surveyed mid-sized mammals using scent stations and noted a decreasing trend in detections with increasing age of the CRP field. The decreasing trend was attributed to decreases in ease of movement and prey diversity.

Principles for Application

Wildlife habitat selection and use is a multi-scale phenomenon (e.g., Gehring and Swihart 2004, Best et al. 2001, Johnson 1980). In addition to the within-field factors (vegetation composition, structure, and succession) described above, response to implementation of a particular planting is dependent upon practice-level factors (e.g., size, shape), the landscape context in which those plantings are placed (e.g., to what extent are alternative grasslands available), and how the fields are managed over time.

Field Size, Shape and Landscape Context

The size of a grassland patch and its surrounding landscape can markedly influence the use of that site by grassland birds. Some patches may be too small to be colonized by certain species, or birds using smaller patches may suffer more from competition or predation than do birds in larger patches. Also, smaller patches have a relatively greater proportion of their area near an edge, so edge effects can be more pronounced in smaller patches. Edge effects are phenomena such as avoidance, predation, competition, or brood parasitism that operate at different levels near a habitat edge than in the interior of a habitat patch (e.g., Faaborg et al. 1993, Winter and Faaborg 1999). Brown-headed cowbirds (*Molothrus ater*) are brood parasites; they lay their eggs in nests of other birds and leave them for the host birds to raise, usually to the detriment of the host's own young. Cow-

birds use elevated perch sites to find nests to parasitize; such perches are more frequent along edges of grasslands because of the presence of trees, fence posts, and the like. Isolation from other grassland patches is a landscape feature that can affect either the use by birds or the fate of their nests in a patch.

Each of these factors—patch size, amount of edge, and isolation—can affect 1) the occurrence or density of birds using a habitat patch; 2) reproductive success, through either predation rates or brood parasitism rates; or 3) competition with other species (Johnson and Winter 1999, Johnson 2001). These features have been shown to operate among several species of grassland birds (e.g, Herkert et al. 2003; Winter et al. In press; reviewed by Johnson 2001). In CRP habitat specifically, Johnson and Igl (2001) related the occurrence of species and their densities to patch size in CRP fields. They conducted 699 fixed-radius point counts of 15 bird species in 303 CRP fields in nine counties in four states in the northern Great Plains. Northern harriers, sedge wrens, clay-colored sparrows (*Spizella pallida*), grasshopper sparrows, Baird's sparrows (*Ammodramus bairdii*), Le Conte's sparrows (*Ammodramus caudacutus*), and bobolinks were shown to favor larger grassland patches in one or more counties. In contrast, two edge species, mourning doves and brown-headed cowbirds, tended to favor smaller grassland patches. Horn (2000) sampled 46 CRP fields in North Dakota during 1996 and 1997. He reported bobolinks, grasshopper sparrows, and red-winged blackbirds were more common in large grassland patches than in smaller ones. In contrast, brown-headed cowbirds preferred smaller fields. Field size also was an important factor influencing the occurrence and/or abundance of grassland songbirds in switchgrass plantings in Iowa (Horn et al. 2002). In southeastern Wyoming, Wachob (1997) noted that sharp-tailed grouse favored larger CRP patches for nesting but not for brood-rearing. Conversely, Rodgers (1999) postulated that pheasants in western Kansas had not benefited from CRP as much as expected due to the large size of the plantings.

Use of CRP (CP1, CP2 and CP10) fields by several grassland-dependent species in Ohio was related to field size (eastern meadowlarks and bobolinks) or field size plus adjacent grasslands (grasshopper sparrows) (Swanson et al. 1999). All species recorded in this study were more abundant in CRP fields contiguous with other grassland.

McCoy (2000) compared measures of grassland bird use and habitat quality between CRP fields located in landscapes with high (20-35 percent) or low (5-12 percent) amounts of CRP and high (55-75 percent) or low (20-35 percent) amounts of grassland. Dickcissels and sedge wrens were more likely to be present in CRP fields in landscapes with higher levels than lower levels of CRP. Total species richness was highest in high CRP, high grassland landscapes, and total bird abundance was higher in high grassland than low grassland landscapes, but there were no similar effects for grassland birds as a group. Nesting success was higher for wild turkey (*Meleagris gallopavo*) in high grassland than low grassland landscapes, and was higher for red-winged blackbirds in high CRP than low CRP landscapes.

Best et al. (2001) investigated the effect of landscape context, including proportion in CRP, on avian use of rowcrop fields in Iowa. Some species showed a strong response to landscape composition (including dickcissel and indigo bunting [*Passerina cyanea*]), while others did not (e.g., American robin [*Turdus migratorius*], American goldfinch, and killdeer [*Charadrius vociferus*]). Seven species differed significantly between landscapes; for these the lowest numbers in crop fields occurred in areas of intensive agriculture. Species with different habitat affinities (grass or wood) showed similar aversion to rowcrops. Grassland birds occurred more often in landscapes with more grass (block or strip). Generalists, crop specialists, and aerial foragers were not affected by landscape composition.

Merrill et al. (1999) compared landscapes (1.6-km radius) surrounding greater prairie-chicken leks with random non-lek points and found greater amounts of CRP in the landscape for leks. Toepfer (1988) documented nesting in Minnesota CRP, but success was lower in CRP than in native grasslands (J. Toepfer, unpublished data, in Merrill et al. 1999). The shape of grassland and woodland patches was significant but had low predictive power for comparisons between temporary and traditional leks. Merrill et al. (1999) believed CRP might be important, especially near temporary lek sites. Svedarsky et al. (2000) recommended that 30 percent of the grassland surrounding greater prairie-chicken leks be managed to provide spring nesting cover and be in close proximity to brood cover to maintain populations. Wachob (1997) noted that sharp-tailed grouse leks were

more common closer to CRP fields and in areas with extensive CRP within 0.6 mile (1 km).

Recent studies have examined the landscape scale effects of CRP across large regions. Riffell and Burger (2006) examined the abundances of 15 bird species associated with grasslands in the eastern United States and found positive correlations between bird abundance and amount of CRP in the landscape. Bird responses varied by species and by ecological region, but tended to be stronger in regions where grasslands were relatively scarce. Similarly, Veech (2006a) investigated the relationship between northern bobwhite population trends and land use across its range. He found that landscapes with increasing populations had significantly more useable land (e.g., cropland and grassland). In a separate analysis, Veech (2006b) examined the population trends of 36 grassland nesting birds in the Midwest and Great Plains relative to land use. Restored grasslands (e.g., CRP) were typically rare, but were more common in landscapes with increasing than decreasing populations.

In contrast to these studies, Hughes et al. (2000) found that mourning dove Daily Survival Rate (DSR) was influenced by vegetation structure within the field, but not field edge or landscape (800 m) factors. Landscape effects were thought to be lacking due to the generalist nature of doves. For ring-necked pheasants in northwestern Kansas, the amount of CRP in areas where home ranges were located had no detectable effect on size of home ranges (Applegate et al. 2002). Females tended to have smaller home ranges (average of 127 ha) in high-density (25 percent) CRP sites than low-density (8 to 11 percent) CRP sites (average 155 ha), but males showed the reverse trend. Horn et al. (2002) also found no effect of landscape on the relations between avian occurrence, abundance, and field size. They noted that the literature is contradictory concerning landscape effects on area sensitivity and postulated that the amount of woodland cover, ranges in field sizes among landscapes, and amounts of shrub and forb cover within CRP fields may have confounded any relationship with landscape composition.

Management Practices

As previously mentioned, plant communities on CRP grasslands are not static, but rather change in species composition and structure over the 10-year lifespan of the contract. Successional changes can be mitigated through management practices such as mowing, disking, burning, or herbicide applications. Until the 2002 reauthorization, grazing and haying were not permitted practices under the CRP, except during weather-related emergencies (e.g., drought). All management practices effect wildlife populations indirectly through changes in vegetation structure, but also directly as a potential cause of mortality.

Mowing or clipping is the most common management practice implemented on CRP grasslands. McCoy et al. (2001b) reported that mowing had short-term effects on vegetation structure (reduced height within the year and increased litter accumulation) and resulted in accelerated grass succession and litter accumulation. Dykes (2005) characterized vegetation structure on 45 CP2 fields in Tennessee and reported that litter cover and depth were greater on fields that had been mowed than those that had been burned. Litter cover and depth were intermediate on unmanaged fields. Conversely, forb coverage was greatest on burned fields, followed by unmanaged and mowed fields (Dykes 2005).

Effects of mowing and haying on wildlife have been fairly well studied. These effects can be divided according to temporal category: immediate, short-term, and long-term. Immediate effects usually include the destruction of nests that are active in the field at the time, fatalities of nesting adults or dependent young, and abandonment of nests or breeding territories that had been established in the field (Rodenhouse and Best 1983, Warner and Etter 1989, Bollinger et al. 1990, Frawley and Best 1991, Dale et al. 1997, McMaster et al. 2005). For example, Labisky (1957) observed that 78 percent of mallard (*Anas platyrhynchos*) and blue-winged teal (*Anas discors*) nests in alfalfa fields were destroyed by haying. In their study of bobolinks (*Dolichonyx oryzivorus*), Bollinger et al. (1990) found that mowing accounted for 51 percent direct mortality in active nests. Subsequent causes of mortality in eggs and of nestlings included abandonment after mowing (24 percent), raking and baling (10 percent), and predation (9 percent); only 6 percent of the clutches fledged successfully. In addition, removal of the vegetation by haying exposes surviving birds, especially young ones, to greater predation pressure (e.g., George 1952, Bollinger et al. 1990).

To mitigate these immediate effects, USDA prohibits regular management activities in CRP grasslands during a set "Nesting Season"; emergency management is also affected. The start date, end date, and length of this restricted period vary from state to state (even by county within some states) based on consultations between USDA and USFWS. A table containing these dates, as well as permissible periods for management under the new Managed Haying and Grazing provision of the 2002 Farm Bill, can be found on the Internet (www.fsa.usda.gov/dafp/cepd/crp/nesting.htm). Restricting management activities to outside the peak nesting period likely has a positive impact on nesting success of grassland birds. However, the benefit of this restriction to populations has not been evaluated and may be limited by annual fluctuations in the timing of peak nesting with annual weather patterns, inability to protect late-season nesting/renesting attempts, and a general lack of attention among researchers and managers to the habitat needs of post-fledgling birds.

We consider short-term effects to be those that manifest within about a year after the management action. Johnson et al. (1998) assessed densities of breeding birds in hayed versus idled grassland that had been restored under the Conservation Reserve Program the year after haying occurred. Because the authors used the same fields in all years, they had essentially a before-and-after, treatment-and-control design. They had data from nearly 300 fields that had been hayed and more than 2,600 fields that had been left idle in the previous year; study fields were in eastern Montana, North Dakota, South Dakota, and western Minnesota. Three species typically had heightened densities the year following haying; these were horned lark, chestnut-collared longspur, and lark bunting, all of which favor short and sparse vegetation. The densities of many more species, in contrast, were reduced the year following haying, including vesper sparrow, sedge wren, common yellowthroat, bobolink, clay-colored sparrow, dickcissel, red-winged blackbird, and Le Conte's sparrow. Some species had responses that varied by study site (and associated climatic regime). Savannah, grasshopper, and Baird's sparrows tended to respond negatively to mowing in the more arid western study sites but positively in study sites with greater precipitation.

Horn and Koford (2000) reported fewer sedge wrens and, possibly, clay-colored sparrows, Le Conte's sparrows, and red-winged blackbirds in mowed than in uncut portions of 12 CRP fields (in North Dakota) in the year after mowing. Savannah sparrows and possibly grasshopper sparrows showed the opposite tendency, being more common in mowed CRP.

McCoy et al. (2001a) examined the influence of mowing on birds wintering in CRP fields in Missouri. They noted that mowing of cool-season CRP plantings in late summer and early fall permitted sufficient regrowth to provide habitat for wintering birds. In contrast, the value of mowed warm-season planting was reduced for at least two years.

As might be expected, birds that prefer heavy cover for nesting typically prefer uncut vegetation. For example, Oetting and Cassel (1971) reported that significantly more ducks nested in unmowed stretches of roadside right-of-way than in adjacent mowed stretches. Also, Renner et al. (1995) found that the density of nests of five species of ducks was lower in portions of CRP fields that had been hayed the previous year than in the uncut portions. Overall, densities were twice as high in the uncut vegetation. The earliest nesting species, mallard and northern pintail, especially avoided the hayed portions until sufficient regrowth had occurred. Analogously, Luttschwager et al. (1994) observed a shift in the species composition from mostly mallards in uncut CRP field to primarily blue-winged teal in hayed CRP fields.

It is worth mentioning here that grazing may increasingly be used as a management technique under the new Managed Haying and Grazing provision of the 2002 Farm Bill. Because grazing of CRP historically has been restricted to emergency situations (e.g., drought conditions), little direct information is available. Whereas there has been much research on grazing and birds in rangeland systems, the results are often contradictory (see Ryan et al. 2002 and references therein). In general, grazing, like mowing and haying, can negatively impact wildlife directly or indirectly. Direct effects may include trampling and exposure due to reduced vegetation structure. Indirect effects may include increased exposure (thermal) and predation due to vegetation removal and composition shifts. However, grazing does not impact all birds negatively. Reduced structure may prompt some birds to avoid grazed pastures, but at-

tract other species. Grazing impacts are complex and depend upon the species under consideration, grazing regime (i.e., grazing intensity, timing, frequency, and the livestock species), and other biotic and abiotic factors (Ryan et al. 2002). As noted above, USDA attempts to mitigate direct effects of grazing through timing restrictions, but the benefit of such restrictions is difficult to guage.

Although our focus has been on breeding birds, there is some relevant information on other taxa, specifically some mammals. For example, Westemeier and Buhnerkempe (1983) noted that nests of small mammals (*Microtus ochrogaster* and *Synaptomys cooperi*) and cottontail rabbits (*Sylvilagus floridanus*) were most abundant in prairie grasses left undisturbed, indicating that they would respond negatively to haying. Leman and Clausen (1984) also commented that meadow voles (*Microtus pennsylvanicus*) and prairie voles (*M. ochrogaster*) were significantly less common on plots with lower residual vegetation; those plots were the ones mowed most recently. In contrast, deer mice (*Peromyscus maniculatus*) were more common on the most recently mowed plot.

By long-term effects, we refer to those occurring more than a year afterward. In addition to the above finding by McCoy et al. (2001) about effects persisting at least two years, Johnson et al. (1998) discovered delayed responses to haying of CRP fields. Some species, such as lark bunting, Le Conte's sparrow, and clay-colored sparrow, showed a response in the second year after haying that was similar to, albeit weaker than, the response in the first year. Although the response by horned larks to haying was positive rather uniformly in the first year, responses in the second year varied geographically, being negative in the drier, western study sites but positive in the more mesic eastern sites. Sedge wrens, reduced the first year after haying, tended to increase the second year. Several species, including common yellowthroat, red-winged blackbird, and bobolink, showed no consistent pattern two years after haying, despite broadly negative responses the first year after haying.

Our knowledge on the effects of other management practices is limited. Madison et al. (1995) examined the effects of fall, spring, and summer disking and burning, and spring herbicide (Roundup®) treatments on bobwhite brood habitat quality in fescue-dominated, idle grass fields in Kentucky. They reported that during the first growing season following treatment, fall disking significantly enhanced brood habitat quality by increasing insect abundance, plant species richness, forb coverage, and bare ground relative to control plots. However, the benefits of disking were relatively short-lived, with diminished response during the second growing season. During the second growing season following treatment, herbicide treatments provided the best brood habitat quality. Greenfield et al. (2002), examining the effects of disking, burning, and herbicide on bobwhite brood habitat in fescue-dominated CRP fields in Mississippi, likewise reported that disking and burning improved vegetation structure for bobwhite broods during the first growing season after treatment. However, the benefits were short-lived (one growing season). Herbicide treatment in combination with prescribed fire enhanced quality of bobwhite brood habitat for the longest duration (Greenfield et al. 2002).

Concerns or Opportunities

The CRP was amended in the 2002 reauthorization to require mid-contract cover management (i.e., incorporating native seeds, light disking, and burning) on all new covers under new contract (USDA 2003). Additionally, the original provision prohibiting commercial uses of CRP lands was amended to allow managed haying and grazing, as well as biomass harvests and the installation of wind turbines. Whereas managed haying and grazing was specifically restricted to one in three years, no federal guidelines were issued for biomass harvests and cover management practices.

Grasslands are disturbance-dependent ecosystems, so it is natural to consider the role of disturbance in established grasslands compared with natural prairies. Grasslands evolved with, and indeed were maintained by, fire and grazing. Fire was especially important in eastern prairies and the tallgrass prairie, where frequent—often annual—fires restricted the encroachment of woody vegetation. In western prairies especially, bison (*Bison bison*) and other native grazers maintained viable grasslands. Mowing, haying, and disking

are disturbances that are now common in agricultural settings but did not occur naturally. It is reasonable to contemplate if and how those activities should be used in establishing and maintaining grasslands. In our view, human disturbance of established grasslands that mimics the natural disturbance regimes will better provide for species that evolved with grasslands.

Mandated disturbance will address some shortcomings of CRP grasslands as wildlife habitat but also raise some concerns. Management practices such as burning and grazing may mimic natural disturbances, especially if used in combination. By removing vegetation, these practices are likely to benefit grassland bird species associated with shorter, sparser grasslands. If these practices occur in a patchy distribution within a field, across the landscape, and through time, a mosaic of grassland successional stages may form that can sustain a wider array of species. However, if a uniform management is applied to most fields in a landscape (i.e., the same practice applied to whole fields at the same time of year and in the same years), conservation goals for a wide range of species will not be accomplished.

CRP management can only be applied according to a detailed conservation plan (USDA 2003). We recommend such plans carefully consider the timing of management actions. From a purely agricultural perspective, grasses and associated forbs should be harvested at or near the peak of their nutritional quality. That strategy conflicts with providing habitat for nesting birds. The immediate effects of haying are extremely detrimental, of course, but they can be largely avoided by delaying haying until after the bulk of nesting activities has ceased. Establishing a reasonable date to begin haying depends on many factors, including the location (especially latitude) of the site, the phenology at the site in the particular year, the breeding-bird community associated with the site, and weather conditions. Similarly, these factors need to be considered when planning the timing and length of grazing. Other management practices, such as burning, disking, and harvesting biomass for energy (e.g., co-firing switchgrass with coal) can generally be done outside the nesting season and therefore pose less of a dilemma.

Another consideration is the frequency of management. Irregular management will result in a greater variety of grassland successional stages and provide for a wider array of species. Decisions on how frequently to manage a field depend on many of the same factors as for the establishment of haying dates discussed above. For example, as a result of longer growing seasons and greater rainfall, the rate of natural succession on CRP grasslands throughout the Southeast likely exceeds that observed in the Midwest or Great Plains, making planned disturbance even more important for maintaining habitat quality for early successional species.

Although USDA (2003) contends that wind turbines "generally have a limited impact on wildlife," their impact may be dependent on placement (e.g., near migratory routes) and species-specific susceptibilities. Avian mortality at wind farms appears to be low relative to the number of birds passing over them, or to communication towers and other tall structures (see Johnson et al. 2002 and references therein). However, turbines may add to the cumulative declines of some species. Wind farms appear to have very little effect on resident bats in Minnesota (Johnson et al. 2004) and Iowa (A. A. Jain, unpublished data). However, substantial numbers of migrating bats suffered collision deaths in both studies. More study is needed to fully understand the impacts of wind turbines on wildlife.

Links with Other Systems

Grasslands established under CRP, or any other program, are linked to varying degrees with other systems in the landscapes in which they are embedded. Perhaps the closest and most important linkage is with riparian and aquatic systems. As mentioned in the introduction, CRP was originally targeted at highly erodible soils to improve and protect water quality. CRP continues to provide those benefits through regular sign-ups and extensions of the program targeted at high value conservation (i.e., Conservation Reserve Enhancement Program). CRP grasslands tend to be established in landscapes already containing more grassland and woodland areas (Weber et al. 2002), likely because these areas tend to have higher slopes and are more difficult to farm than relatively flat areas. These areas also present higher risk to aquatic systems from agricultural runoff of sediment, nutrients, and chemicals. The

Farm Service Agency is currently funding projects to estimate the water quality benefits provided by CRP practices in various regions of the country (S. Hyberg, personal communication).

Conclusions

Establishing grasslands has important implications for wildlife, especially in areas historically rich in grasslands that have since been converted to row crop agriculture. Most grassland established under farm conservation programs has replaced annual crops with perennial cover that provides year-round resources for wildlife. Which wildlife species benefit from grassland establishment depends on many factors at multiple spatial and temporal scales. These factors include within-field factors (vegetation composition, structure, and succession), practice-level factors (e.g., size, shape), the landscape context in which those plantings are placed (e.g., to what extent additional grasslands are available), the season or life-cycle stage the species uses the grassland for, and how the fields are managed over the life of the contract.

Periodic management, especially practices that profit land owners, is a relatively new mandate for established grasslands. It can be argued that as disturbance-dependent systems, grasslands should be manipulated periodically. Such disturbances, however, should occur no more often than is necessary; the frequency depends on factors such as precipitation and species composition of the plants. It should be remembered that the response by breeding birds to such disturbances will depend on the location of the site relative to the breeding ranges of various bird species, the habitat preferences of species whose ranges encompass the site, the environmental conditions—especially soil moisture—prevailing, and the timing of the disturbance. For example, Baird's sparrows prefer grassland habitat with moderately deep litter, vegetation height between 20 and 100 cm, moderately high but patchy forb coverage, and patchy grass and litter cover with little woody vegetation (Dechant et al. 2003). Creating such habitat in Wisconsin, for example, which is well outside the breeding range of the species, is unlikely to provide any benefits to the species. Also, mowing grassland in September will have far different consequences than mowing it in May. Vegetation will recover from mowing much more quickly when soil moisture is high than when it is not. Further, management scenarios that benefit one species will benefit some others but also exclude some. These considerations lead to the conclusion that a "one size fits all" approach to managing grasslands will not work. ■

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