Impact of the Conservation Reserve Program on Wildlife Conservation in the Midwest

D. Todd Farrand
Department of Fisheries and Wildlife Sciences
University of Missouri
Columbia, MO 65211, USA
Farrandd@missouri.edu

Mark R. Ryan
Department of Fisheries and Wildlife Sciences
University of Missouri
Columbia, MO 65211, USA
RyanMR@missouri.edu

Abstract
Evidence that the Conservation Reserve Program (CRP) created habitat used by grassland birds in the Midwest is unquestionable. Evidence also is accumulating that suggests CRP is used by a variety of other terrestrial wildlife species. Reproductive and population-level benefits have been demonstrated for some, but not all, avian species; evidence for other terrestrial wildlife is lacking. Wildlife response to CRP is a multiscale phenomenon dependent upon vegetation structure and composition within the planting, practice-level factors such as size and shape, and its landscape context, as well as temporal factors. Thus, the benefits of CRP and the impacts of recent programmatic changes are location- and species-specific. Overall, CRP habitat in the Midwest likely contributes to the population stability and growth of many, but not all, grassland wildlife species.

Introduction
Since its inception in 1985, the Conservation Reserve Program has influenced wildlife conservation in the United States. With each reauthorization of farm policy legislation (in 1990, 1996, 2002), CRP has expanded in terms of acreage and the emphasis given to providing wildlife habitat. The 2002 Farm Bill added additional practices (e.g., CP29 wildlife habitat buffer) and management options for landowners, including managed haying and grazing, managed harvesting of biomass, and installation of wind turbines on CRP fields (USDA 2003). These changes will affect the potential of CRP to provide wildlife habitat.

As of January 2005, nearly 7.7 million acres were enrolled in the CRP in 8 midwestern states (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin). The majority of these acres (80%) were enrolled through the competitive general signup, and 4.4 million acres (58%) are whole fields planted to grass. Although new land is expected to be brought into the CRP between 2003 and 2007, many new contracts are likely to be focused on forests, wetlands, and linear buffers, thereby altering the benefits for some species (Riley 2004). Many of the existing contracts are set to expire between 2007 and 2009. Contracts on 34% of existing acreage in the Midwest will expire by the end of 2007, with another 30% expiring over the following 2 years (USDA 2005). The future of these acres and the wildlife benefits they provide is uncertain.

Ryan (2000) reviewed existing knowledge on avian response to grassland CRP plantings (CP1, CP2, CP10) in the Midwest. We build upon that knowledge by emphasizing recently published information on birds (since 1999), as well as presenting available information on other terrestrial wildlife (i.e., mammals, reptiles, amphibians, and invertebrates). Discussion is focused on whole field grass plantings in the tallgrass prairie region (states mentioned above), but studies undertaken outside the Midwest are reviewed when the species of concern occur there.

Wildlife and the CRP in the Midwest

Among the intended objectives of the CRP was an increase in total habitat available for wildlife, especially grassland birds. The implicit assumption underlying this objective was that availability of grasslands was limiting populations of many species of birds. By establishing new grass plantings, it was expected that birds would occupy those fields and successfully reproduce, thereby augmenting their populations. The decline of grassland bird populations over the last half of the 20th century has been well documented by the efforts of the Breeding Bird Survey (BBS) (Sauer et al. 1996). Unfortunately, no other continent-wide survey exists to maintain data on other vertebrate groups. Still, it was widely assumed that the establishment of CRP plantings would positively affect grassland wildlife populations (e.g., Berner 1988). However, wildlife response to changes in land use is species-specific, depending on life-history requirements. Also, wildlife habitat selection and use is a multiscale phenomenon (e.g., Best et al. 2001, Gehring and Swihart 2004). Response to implementation of a particular CRP practice is dependent upon vegetation structure and composition within the planting, practice-level factors (e.g., size, shape), and its landscape context, as well as temporal factors (e.g., succession).

Ryan (2000) identified 6 levels of evidence of a positive impact on conservation of wildlife in the Midwest, from weakest to strongest, that should be investigated:

1) Evidence of use (occupancy) of CRP fields;
2) Evidence of high abundance in CRP relative to alternative vegetation types, especially cropfields that were replaced by CRP;
3) Evidence of nesting in CRP and comparison with alternative vegetation types;
4) Evidence of high reproductive success relative to alternative vegetation types;
5) Evidence of reproductive success and survival in CRP fields sufficient for positive population growth (i.e., $\lambda > 1.0$); and
6) Evidence of positive population growth (or reduced decline) after initiation of the CRP.

Evidence of Wildlife Use of CRP Fields

Birds

There is overwhelming evidence that CRP plantings were used by a variety of bird species. In their review of the literature, Ryan et al. (1998) listed 92 species of birds, including 53 songbirds (Order Passeriformes), that had been observed using CRP plantings in the central U.S. Recent research has added only 1 species to that list; Evrard (2000) noted 3 rough-legged hawks (*Buteo lagopus*) hunting CRP fields in Wisconsin. In the most extensive study of songbird use of CRP in the Midwest, Best et al. (1997) observed over 60 species of birds using CRP habitats during the breeding season. Similarly, Best et al. (1998) recorded over 40 bird species using CRP grasslands as winter-feeding or roosting habitat. 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 row-crop fields.

Pheasant in a CRP field in Iowa. (USDA-NRCS)

Several studies have investigated the impact of field-level (e.g., age, field size) and within-field (e.g., planting mix) factors on avian use of CRP. Eggebo et al. (2003) observed more crowing ring-necked pheasants (*Phasianus colchicus*) in old cool-season CRP fields than in any other age or cover type in South Dakota. Horn et al. (2002) found field size to be an important factor influencing the occurrence and/or abundance of grassland songbirds in switchgrass (*Panicum virgatum*) plantings in Iowa. Swanson et al. (1999) evaluated avian use of CRP (CP1, CP2, and CP10) fields in Ohio as a function of vegetation, physical, and disturbance characteristics. Age and field size were not related to species richness, but the grassland area of the field plus surrounding areas was related to use by several grassland-dependent species. All species were more abundant in CRP fields contiguous with other grassland.

In Missouri, species richness, abundance, and nesting success of grassland birds during the breeding season and total bird use in the winter did not differ between introduced grasses with legumes (CP1) and native grasses (CP2) (McCoy et al. 2001). In contrast, Morris (2000) observed grassland birds using CP2 fields, but not CP1, in winter in southern Wisconsin. 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% forbs, which the authors surmised was too low to produce a response. Murray and Best (2003) found that species richness did not differ between harvest treatments in Iowa switchgrass fields; species preferring taller vegetation were replaced by species preferring shorter vegetation in the harvested treatments. The abundances of 16 of 18 species did not differ with treatment. Sedge wrens (*Cistothorus platensis*) were more abundant in non-harvested than totally harvested fields, while grasshopper sparrow (*Ammodramus savannarum)* abundances differed in all treatments (total > strip > non-harvested). Svedarsky et al. (2000) noted the potential of CRP to provide greater prairie-chicken (*Tympanuchus cupido pinnatus*) habitat if it was managed to maintain grass vigor and reduce woody invasion and litter buildup.

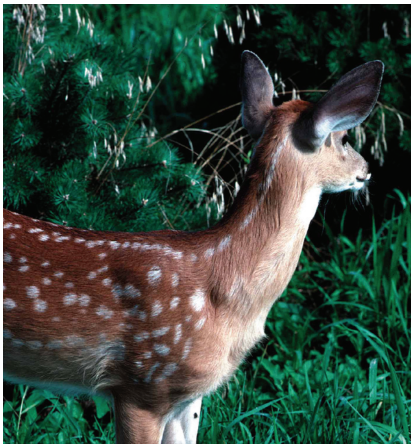
Recent studies also have examined the effect of a CRP field's landscape context on avian use. Merrill et al. (1999) compared landscapes (1.6-km radius) surrounding greater prairie-chicken leks to random non-lek points and found greater amounts of CRP in the landscape for leks. Toepfer (1988) documented 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% 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.

Best et al. (2001) investigated the effect of landscape context, including proportion in CRP, on avian use of row-crop fields in Iowa. Some species showed a strong response to landscape composition (including dickcissel [*Spiza americana*] and indigo bunting [*Passerina cyanea*]), while others did not (e.g., American robin [*Turdus migratorius*], American goldfinch [*Carduelis tristis*], 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 row crop. 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.

In contrast to these studies, Hughes et al. (2000) found that mourning dove (*Zenaida macroura*) daily survival rate 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%) CRP sites than in low-density (8% to 11%) 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. Horn et al. (2002) reported 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.

Mammals

Information on mammalian use of CRP fields is scarce. The majority of available evidence comes from surveys of small mammals, either to assess wildlife habitat quality or estimate the potential to contribute to crop depredation. Eight species of small mammals were captured on CRP fields planted to exotic grasses (CP1) in Michigan (L. T. Furrow, H. Campa, III , S. R. Winterstein, K. F. Millenbah, R. B. Minnis, and A. J. Pearks, unpublished data). Deer mice 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 1–2-year-old fields, which may have contributed to greater small mammal diversity on these age classes. Hall and Willig (1994) captured 10 rodent species on CRP in Northwest Texas, including deer mice and white-footed mice. No significant differences in mammalian diversity were detected among sites, and diversity was not correlated with heterogeneity of vegetation or site age. However, species composition was significantly different among all sites in each season. In a crop-depredation study in Nebraska, Hygnstrom et al. (1996) trapped small mammals in a 9-year-old, 64-ha field planted to brome. Trapped species included (in decreasing order) deer mouse (*Peromyscus maniculatus*), short-tailed shrew (*Blarina brevicauda*), least shrew (*Cryptotis parva*), and meadow jumping mouse (*Zapus hudsonicus*). No voles were captured, although they were observed the preceding season. Meadow voles constituted 95% of captures in Wisconsin (Evrard 2000).



White-tailed deer fawn in Iowa. (L. Betts, USDA-NRCS)

Few studies have directly measured use of CRP by midsized and large mammals. Furrow (1994) noted a decreasing trend in mammal detections at scent stations with increasing age of the CRP field. The decreasing trend was attributed to decreases in ease of movement and prey diversity. From most to least abundant, the 6 species were recorded were raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), marmot (*Marmota monax*), domestic cat, domestic dog, and Virginia opossum (*Didelphis virginiana*). Raccoons were the most abundant detections across field ages in most months sampled, and skunks also were recorded in almost every month. In Northwest Texas, Kamler et al. (2003) reported that both adult and juvenile swift fox (*Vulpes velox*) strongly avoided CRP fields. Whereas CRP comprised 13% and 15% of the available habitat for each age class, respectively, only 1 of 1,204 locations was recorded in a CRP field. Kamler et al. (2003) believed this was due to the taller, denser vegetation of introduced warm-season grass plantings compared to the native shortgrass prairie preferred by swift foxes. 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 in the 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.

Other, more anecdotal information exists for mammalian use of CRP. Hughes et al. (2000) listed potential nest predators at their sites in Kansas including coyotes (*Canis latrans*), raccoons, striped skunks, opossums, feral cats, and badgers (*Taxidea taxus*). Evrard (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 3 pups (Evrard 2000).

Other Wildlife

Other terrestrial wildlife studied or observed in CRP plantings included invertebrates and snakes. Most studies of invertebrates in CRP have been conducted relative to crop pests or avian food supplies. Carroll et al. (1993) assessed CRP grasses (native and exotic) to be marginal over-wintering habitat for boll weevils (*Coleoptera: Curculionidae*) in Texas.

Alternatively, Phillips et al. (1991) detected a low incidence of cotton pests and found beneficial predator species in Texas CRP. Also in Northwest Texas, McIntyre and Thompson (2003) reported that CRP supported avian prey and that CRP types were similar in abundances (i.e., no support that different types of CRP possess different prey availabilities for grassland birds). Millenbah (1993) measured greater insect abundance on 1–2-year-old CRP fields than fields ≥3 years old in Michigan. In Northeast Kansas, data collected by Hull et al. (1996) did not support the hypothesis that invertebrate biomass was correlated positively with forb abundance (but see Burger et al. 1993). McIntyre (2003) surveyed 4 planting types and 1 native prairie in the Texas panhandle for endangered Texas horned lizards (*Phrynosoma cornutum*) and their food supply, harvester ants (*Pogonomyrmex spp.*). 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 all types of CRP, but only at sites with ant nests. Davison and Bollinger (2000) identified 4 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 fields.

Evidence of High Wildlife Abundance in CRP Fields

Birds

Best et al. (1997) compared avian abundance in paired CRP and row-crop fields in 6 midwestern states (Indiana, Michigan, Iowa, Missouri, Nebraska, and Kansas) in the early 1990s. Best et al. (1997) detected from 1.4 to 10.5 times more birds in CRP grasslands than in row-crop fields during the breeding season. Similarly, King and Savidge (1995) reported avian abundance to be 4 times greater in CRP fields than in cropfields in Nebraska. Best et al. (1997) further reported 16 species of birds that were unique or substantially more abundant in CRP fields than in nearby row-crop fields. Three of the 4 bird species they frequently observed in CRP (dickcissels, grasshopper sparrows, and bobolinks [*Dolichonyx oryzivorus*]) have been undergoing significant population declines. Additionally, Henslow's sparrow (*Ammodramus henslowii*) and sedge wren, species of high conservation concern in the Midwest (Herkert et al. 1996), occurred only in CRP fields. Of the 5 species unique or substantially more abundant in row crops than in CRP fields (Best et al. 1997), only the lark sparrow (*Chondestes grammacus*) is of moderate conservation concern (Herkert et al. 1996).

Direct comparisons of avian abundance in CRP and alternative grassland vegetation have been rare. Klute and Robel (1997) documented higher abundances of dickcissels, grasshopper sparrows, meadowlarks (*Sturnella spp.*), and upland sandpipers (*Bartramia longicauda*) in grazed pastures versus CRP plantings in Kansas. Summer observations of pheasants in western Kansas analyzed by Rodgers (1999) showed that pheasants 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 (Evrard 2000). Morris (2000) compared winter use by grassland birds of CRP, crop fields, pastures, and restored and native prairies. In this study, species diversity was highest in crop fields, followed by restored prairie, CP2 fields (a mixture of native warm-season grasses and 2 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. Avian abundance in crop fields and native prairie was higher during periods of incomplete snow cover than during periods with 100% snow cover, while the reverse was true for restored prairie and CP2 sites.

During the winter months, ring-necked pheasants, northern bobwhites (*Colinus virginianus*), American tree sparrows (*Spizella arborea*), dark-eyed juncoes (*Junco hyemalis*), and American goldfinches were the most abundant or widely distributed species observed in CRP fields (Best et al. 1998). All species but the goldfinch have been undergoing long-term population declines (Sauer et al. 1996). In a separate study, Burger et al. (1994) provided evidence that CRP plantings in Missouri provided important winter cover for northern bobwhites. They documented that 69% of nighttime roosts occurred in CRP fields in an area where CRP made up only 15% of the landscape. Rodgers (1999) used dropping counts 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 nighttime roosting. CRP may be less valuable to pheasants in winter due to fewer food sources, excessive litter, and less rigid stems.

Mammals

Comparison of mammal use of CRP relative to other vegetation types has been rare. A 3-phase, winter wheat (*Triticum aestivum*) rotation in southeastern Wyoming had higher rodent abundance and diversity than CRP at both sites in both years (Olsen and Brewer 2003). Evrard (2000) reported a catch/effort ratio for small mammals in Wisconsin of 19.37, much higher than Evrard (1993 [in Evrard 2000]) reported for Waterfowl Production Area (WPA) grasslands (6.8). Hall and Willig (1994) found that CRP grasslands simulated shortgrass prairies of Northwest Texas in species 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. White-tailed deer in southeastern Montana used CRP in greater proportion than its availability in all seasons except fall (Selting and Irby 1997).

Other Wildlife

Direct comparisons of other wildlife abundance in CRP and alternative vegetation types have been extremely rare. McIntyre and Thompson (2003) sampled invertebrates with pitfall traps in 4 CRP field types in Northwest Texas and compared trap results with those of a shortgrass prairie. CRP field types had less vegetative diversity and lower arthropod diversity than prairie, but CRP fields did support avian prey groups. McIntyre (2003) found fewer harvester ant mounds on CRP plantings than on indigenous grasslands, but no significant differences between exotic and native CRP plantings.

Evidence of Nesting or Other Reproductive Behaviors in CRP Fields

Birds

CRP plantings have been extensively used for nesting by grassland birds in the Midwest. Murray and Best (2003) found 20 species nesting in switchgrass CRP fields in 1999 and 2000 in Iowa; red-winged blackbirds (*Agelaius phoeniceus*) comprised 56% 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 row crops. In row-crop areas, they most frequently detected 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. 2001). House sparrow (*Passer domesticus*) was the most common avian species nesting in CRP fields in Northeast Kansas (Hughes et al. 1999). CRP also appears to be important nesting habitat for mourning doves 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 (Evrard 2000). In Northwest Texas, Berthelsen et al. (1990) found approximately 6 pheasant nests per 10 acres of CRP land, but no nests in cornfields. In Missouri, 55% of northern bobwhite nests and 46% of brood foraging locations occurred in CRP fields that constituted only 15% of the largely agricultural landscape (Burger et al. 1994).

Mammals

Evidence of reproductive activity by mammals is rare. Some of this is likely due to incomplete reporting as none of the small mammal papers reviewed mentioned the incidence of pregnant female mice, though this has been recorded in grass filter strips (CP21) in Missouri (D. T. Farrand, unpublished data). The only direct reproductive evidence found was reported by Evrard (2000), who observed a coyote den with 3 pups at 1 site. Indirectly, Gould and Jenkins (1993) concluded that CRP fields were important in South Dakota for female white-tailed deer during fawn-rearing, particularly at night.

Other Wildlife

None of the papers reviewed reported reproductive activity of other terrestrial wildlife species. Although it can be assumed that most semi-aquatic species (e.g., toads) do not use grasslands for reproduction, some reptiles and many invertebrates likely do.

Evidence of High Reproductive Success Relative to Alternative Vegetation Types

Birds

Nest success of birds breeding in CRP fields has been equal to or greater than that reported for alternative agricultural types. Apparent nest success for 1,526 nests monitored in CRP fields by Best et al. (1997) was 40% versus 36% for 113 nests monitored in row-crop fields. Using a subset of the data from Best et al. (1997), Patterson and Best (1996) reported apparent nest success of 38% in CRP fields and 32% in row-crop fields in Iowa. McCoy (1996), using the Missouri subset of the Best et al. (1997) data, reported significantly higher Mayfield nest success in CRP fields versus row-crop fields in 2 of 3 years (1993: CRP = 45%, row crop = 12%; 1995: CRP = 46%, row crop = 9%; 1994: CRP = 43%, row crop = 53%).

Pheasant population indices and Mayfield estimates for blue-winged teal (*Anas discors*) and mallards (*A. platyrhynchos*) in CRP did not differ from fields in WPA in Wisconsin (Evrard 2000). McCoy et al. (1999) noted that reproductive success of grasshopper sparrows, field sparrows (*Spizella pusilla*), dickcissels, American goldfinches, and common yellowthroats (*Geothlypis trichas*) breeding in CRP fields in Missouri was similar to or higher than that reported from alternative grasslands in a variety of prior studies. Klute et al. (1997) compared Mayfield nest success of 7 species breeding in CRP fields and pastures in Kansas. They detected no differences; however, sample sizes of nests were very small. Granfors et al. (1996) reported Mayfield nest survival for eastern meadowlarks (*Sturnella magna*) in CRP and grazed grasslands in Kansas. Nest success in CRP and grazed grass did not differ (1990: CRP = 17%, grazed = 25%; 1991: CRP = 10%, grazed = 20%), but they noted the low power of their statistical tests. Gransfors et al. (1996) also reported no difference in the mean number of nestlings fledged, for radiomarked females occupying CRP and grazed fields (CRP = 1.9 fledged/female, grazed = 0.7).

Recently published studies have compared reproductive success among CRP planting types and management regimes. McCoy et al. (2001) found that 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 blackbirds. Parasitism rates did not differ between conservation practices (CPs) for any species, but varied with host species (mean = 18%, range = 0–40%). More pheasant broods were recorded in old cool-season than in warm-season CRP fields in South Dakota (Eggebo et al. 2003). Murray and Best (2003) found that non-harvested switchgrass fields had higher nest success and lower predation than strip-harvested or total-harvested fields. Failure due to brood parasitism did not differ between treatments. Grasshopper sparrow nest success in total-harvested fields (48%) was similar to that reported for Missouri by McCoy et al. (2001) (49% in warm-season and 42% in cool-season plantings). However it was higher than that reported for cool-season grass plantings in Iowa (Patterson and Best 1996). Common yellowthroat daily survival rate did not differ between treatments, and nest success was higher (41%) than reported in Missouri (McCoy et al. 2001; 32% in warm-season and 21% in cool-season plantings).

Mammals and Other Wildlife

We found no published data on reproductive success of mammals, reptiles, amphibians, or invertebrates relative to other vegetation types.

Evidence of Reproductive Success or Survival Adequate for Positive Population Growth

Birds

We found no published data on survival of adult or post-fledging juvenile birds in CRP. Few studies have examined fecundity in CRP; most research examined nest success (defined as ≥1 nestling fledged per nest) and implicitly assumed nest survival is the limiting factor in population growth. Duck species are the best studied in terms of reproduction. In Wisconsin, Mayfield nest success for blue-winged teal and mallards in CRP fields was above the level needed for population stability, but duck production was lower in CRP fields due to lower estimated nest densities (Evrard 2000).

McCoy et al. (1999) quantified seasonal fecundity for 8 grassland bird species breeding in CRP fields in Missouri and assessed whether it was adequate to offset annual mortality (i.e., achieve $\lambda > 1.0$). They concluded that CRP fields were of sufficient quality for 4 species (grasshopper sparrow, field sparrow, eastern meadowlark, and American goldfinch) to produce young in excess of that needed to maintain stable populations. Common yellowthroat reproductive success in CRP fields varied substantially among years, with output being in excess of that needed for maintenance of a stable population in only 1 of 3 years (McCoy et al. 1999). Fecundity of dickcissels and nesting success and fecundity of red-winged blackbirds were higher on CP2 than on CP1 habitat, but both CPs were likely sinks ($\lambda < 1$) for these species. Both CPs were likely source (>1) habitat for grasshopper sparrows, whereas only CP1 fields were likely a source for eastern meadowlarks and American goldfinches (McCoy et al. 2001).

Murray and Best (2003) found that nest success rates of grasshopper sparrows in total-harvested fields and common yellowthroats in all management treatments were similar to those reported for switchgrass fields by other studies, and thought they might be sufficient to maintain stable populations. Mourning dove apparent nest success averaged 56% ($n = 90$) in CRP fields in Kansas (Hughes et al. 2000), among the highest estimates they found in the literature. Although Hughes et al. (2000) postulated that CRP may be a source habitat for increasing populations of doves in the Great Plains, they made no attempt to calculate the source–sink status of CRP fields they studied.

Recently published studies of dickcissels nesting in CRP found nest success rates within the range of those summarized by McCoy et al. (1999). On 11 CRP fields in Northeast Kansas, Hughes et al. (1999) located 186 dickcissel nests, of which 13.2% were successful in 1994 and 14.9% were successful in 1995. Davison and Bollinger (2000) reported apparent nesting success in east-central Illinois averaging 39% over the entire nesting cycle and 59% during approximately 12 days of incubation. Robel et al. (2003) observed natural dickcissel nests in 5–6-year-old CRP fields in northeastern Kansas planted to native warm-season grasses. Of 97 nests, 68 (70%) were lost to predation or abandonment. A daily survival rate of 0.92 was calculated using the Mayfield method. Maddox and Bollinger (2000) observed male dickcissels feeding nestlings in Illinois CRP fields in 1997 but not in 1998. This extremely rare behavior was postulated to be a response to low food supplies.

Patterson and Best (1996) reported apparent nest success of ring-necked pheasants breeding in Iowa CRP fields as 34%, considerably higher than that reported for alternative agricultural fields studied previously in Iowa (see Ryan et al. 1998 for review). The 34% rate reported by Patterson and Best (1996) exceeded the level of nest success predicted by Hill and Robertson (1988) as necessary to maintain stable populations. However, Warner et al. (1999) reported that chick survival on their study area in Illinois remained low from 1982 to 1996 despite increases in brood habitat provided by CRP.

No direct measures of survival of grassland birds occupying CRP fields for all or significant portions of the annual cycle are available. However, Burger et al. (1995) did not detect a difference in annual survival of northern bobwhites occupying a landscape comprised of 15% CRP fields (5.4%) versus an agricultural area without CRP (5.1%).

Mammals and Other Wildlife

We found no published data on survival or reproductive success of mammals, reptiles, amphibians, or invertebrates relative to other habitats.

Evidence of Population Growth Related to CRP Fields

Birds

Murphy (2003) examined the impact of changes in agricultural land-use variables on population indices of grassland and shrubland bird species in the eastern and central U.S. from 1980 to 1998. Both groups experienced declines (15 of 25 and 13 of 33 species, respectively), but only the grassland bird group had an average rate significantly less than zero. Declines in grassland bird populations were independent of migratory behavior or nesting ecology. Changes in landscape variables accounted for more of the variation in grassland than shrubland bird population trends. Most of the trends significantly correlated to CRP acreage were negative (7 of 8); only the loggerhead shrike (*Lanius ludovicianus*) was positively correlated with increases in CRP acreage. Of the species negatively correlated with CRP, most (5 of 7) were shrubland species and the others nest in sparse grasslands—a condition CRP does not continually provide without management (e.g., Greenfield et al. 2002, 2003). Lack of positive relationships may be due to the fact that recent areas of CRP expansion tended to be in the eastern U.S. (outside most grassland bird ranges) or the relatively small land area in CRP. CRP comprises only 3.6% of the eastern and central U.S. and may be overwhelmed by other factors (Peterjohn 2003).

Based on Breeding Bird Survey data from Illinois, Herkert (1997) demonstrated a significant positive relationship between the population trend for Henslow's sparrow and the percentage of CRP in a county. Five of 8 counties with ≥3% of the area in CRP had positive population trends for Henslow's sparrow, whereas 8 of 11 counties with <3% CRP had negative trends. Unfortunately, the effect of CRP establishment was not sufficient to reverse the long-term declining trend in Henslow's sparrows in Illinois (Herkert 1997). However, recent reanalysis by Herkert (2004), using BBS data from the last 8 years (1995–2003), has shown that population trends are still positively correlated with CRP enrollments and that Illinois' populations of Henslow's sparrow are now at a 30-year-high level. Herkert (1998) reported a significant change in the slope of the population trend for grasshopper sparrows after the initiation of the CRP. In the 8 years prior to the CRP, 179 (64%) of 278 Breeding Bird Survey routes had negative trends. In the 8 years after, only 149 (54%) of the routes had negative trends. The overall trend prior to CRP initiation was strongly negative, but was essentially level during the CRP years. Herkert (1998) also showed a greater increase in trend slopes in areas with higher CRP acreages (>3.8% of the landscape). However, in the last 8 years (1995–2003) population trends again have become negative and are declining at a rate comparable to pre-CRP conditions (Herkert 2004).

Hughes et al. (2000) reported that mourning dove numbers have increased in the Great Plains region since the mid-1980s when the CRP was initiated. Mueller et al. (2000) quantified the relative effects of Minnesota CRP on abundance and distribution of mourning doves and found dove indices were positively related to CRP abundance.

Haroldson et al. (2004) quantified the relationships between amount of CRP fields in 15 agricultural landscapes in Minnesota and relative abundance of ring-necked pheasants, gray partridge, and meadowlarks in south-central Minnesota over a 10-year CRP enrollment cycle. For each 10% increase of grass in the landscape, pheasant indices averaged 12.4 birds/route higher in spring and 32.9 birds/route higher in summer, and meadowlark indices averaged 11.7 birds/route higher in summer. Partridge indices declined dramatically regardless of amount of grass habitat available. Pheasant populations in Nebraska increased from <2 birds/100 miles of survey route during 1983–1985 to >10 birds/100 miles in 1994 as CRP was established. King and Savidge (1995) reported significantly more pheasant observations in study areas with 18–21% CRP landscape coverage versus areas with 2–3% CRP. In Iowa, Riley (1995) compared pheasant populations in the 5 years immediately prior to CRP initiation with those in the first 5 years after establishment. He recorded a significant increase in mean detections from 37/survey route to 48/route.

Most of the change occurred where CRP was established in landscapes initially comprised of >70% cropland.

Rodgers (1999) used long-term survey data to show that pheasant populations have not responded to increased grassland acreages due to CRP, and deduced that deterioration of abundant wheat stubble fields represented an overwhelming habitat loss in western Kansas for which CRP could not compensate. Additionally, the author postulated that anticipated pheasant benefits from CRP were not fully realized because of inadequate plant diversity, poor stand maintenance, and large field size. Warner et al. (1999) found that ring-necked pheasant chick survival remained low despite increases in grassland and food supplies in central Illinois since the early 1980s. Similarly, Roseberry and David (1994) detected no relationship between northern bobwhite population indices and amounts of CRP in the landscape in Illinois.

Mammals and Other Wildlife

Mueller et al. (2000) quantified the relative effects of Minnesota CRP on abundance and distribution of white-tailed jackrabbits, eastern cottontail rabbits (*Sylvilagus floridanus*), and white-tailed deer. In the 32 counties analyzed, CRP accounted for 91% of the increase in grassland acreage in the post-CRP period (1986–1997) over the pre-CRP period (1974–1985). Cottontail indices were positively related to CRP abundance, whereas jackrabbit indices were negatively related, and deer indices were not influenced. Gould and Jenkins (1993) concluded that CRP enhanced habitat options (improved forage and cover) for white-tailed deer, but would have little population consequences other than influencing harvest mortality by providing escape cover.

Respondents to a survey of landowners in Riley County, Kansas, by Hughes and Gipson (1996) felt that several wildlife species causing damage on their property had become more common due to CRP. White-tailed deer accounted for 64.3% of these observations, followed by wild turkey (*Meleagris gallopavo*), eastern cottontail, striped skunk, and opossum, which accounted for 14.3%, 7.1%, 7.1%, and 7.1% of the damage observations, respectively.

Conclusions

Significant new information has accumulated on wildlife response to the CRP, especially in terms of terrestrial wildlife use and the population response of grassland and shrubland birds. This information reveals the complex nature of wildlife response to changes in land use; research has come to conflicting conclusions regarding the benefits of CRP across and within species. Some of this is due to differences in methodology (especially true of invertebrate sampling), while some is due to differences in species' response by landscape (e.g., Best et al. 2001) or region (e.g., Morris 2000 vs. McCoy et al. 2001). Much more work needs to be done to understand the causes of this complexity and to fill holes in our understanding of CRP effects, especially in relation to effects on populations of non-avian wildlife.

Wildlife response to CRP is a multiscale phenomenon dependent upon vegetation structure and composition within the planting, practice-level factors (e.g., size, shape), and its landscape context, as well as temporal factors. Thus, changes in the CRP resulting from the 2002 re-authorization (e.g., managed haying and grazing) will impact each species uniquely. We know enough to predict the response of some avian species in some landscapes (e.g., Murray et al. 2003), and as information on additional wildlife species accumulates we will be better able to tailor the program. However, several studies have shown that vegetation conditions outside the CRP may have a bigger impact than CRP on avian populations (e.g., Rodgers 1999, Warner et al. 1999, Murphy 2003), and this may well be true for other wildlife (e.g., Kamler et al. 2003). CRP grasslands are only a small proportion of U.S. land area (Peterjohn 2003), constitute a small amount of total grassland (Herkert 2004), and tend to be implemented in landscapes already characterized by greater diversity (Weber et al. 2002). Thus, CRP's vital importance to wildlife conservation in intensive agricultural areas may need to be augmented by other changes in land management if we are to reach desired conservation goals.

Remaining Questions

To better evaluate the impact of the CRP on wildlife conservation and to improve the efficiency (i.e., increased conservation benefits per dollar expended) several lines of additional research are needed:

- Direct comparisons of abundance and reproductive success of species breeding in native prairie and CRP grasslands;
- Further evidence of population-level change attributable to the availability of CRP grasslands at regional levels;
- The effects of distribution of CRP plantings in different landscape contexts on avian use and reproductive success in CRP fields (e.g., should CRP contracts be clumped or dispersed in landscapes with high or low amounts of existing grassland?);
- Comprehensive analyses of the impacts of types, frequency, and extent of disturbances (e.g., mowing, burning, grazing) of CRP vegetation on avian abundance and reproductive success; and
- Greater focus on non-avian wildlife response to CRP fields, including nest-predator species.

Literature Cited

Applegate, R. D., B. E. Flock, P. S. Gipson, M. W. McCoy, and K. E. Kemp. 2002. Home ranges of ring-necked pheasants in northwestern Kansas. Prairie Naturalist 34:21–29.

Berthelsen, P. S., L. M. Smith, and R. R. George. 1990. Ring-necked pheasant nesting ecology and production on CRP lands in the Texas southern high plains. Transactions of the North American Wildlife and Natural Resources Conference 55:46–56.

Berner, A. H. 1988. The 1985 Farm Act and its implications for wildlife. Pages 437–466 in W. J. Chandler, editor. Audubon wildlife report 1988/1989. Academic Press, San Diego, California, USA.

Best, L. B., T. M. Bergin, and K. E. Freemark. 2001. Influence of landscape composition on bird use of rowcrop fields. Journal of Wildlife Management 65:442–449.

———, H. Campa, III, K. E. Kemp, R. J. Robel, M. R. Ryan, J. A. Savidge, H. P. Weeks, and S. R. Winterstein. 1997. Bird abundance and nesting in CRP fields and cropland in the Midwest: a regional approach. Wildlife Society Bulletin 25:864–877.

———, ———, ———, ———, ———, ———, ———, and ———. 1998. Avian abundance in CRP and crop fields during winter in the Midwest. American Midland Naturalist 139:311–324.

Burger, L. W., T. V. Dailey, E. W. Kurzejeski, and M. R. Ryan. 1995. Reproductive strategies, success, and mating systems of northern bobwhite in Missouri. Journal of Wildlife Management 59:417–426.

Burger, L. W., Jr., E. W. Kurzejeski, T. V. Dailey, and M. R. Ryan. 1993. Relative invertebrate abundance and biomass in Conservation Reserve Program plantings in northern Missouri. Pages 102–108 in K. E. Church and T. V. Dailey, editors. Quail III: National Quail Symposium. Missouri Department of Conservation, Jefferson City, USA.

———, M. R. Ryan, E. W. Kurzejeski, and T. V. Dailey. 1994. Factors affecting the habitat value of Conservation Reserve Program lands for bobwhite in northern Missouri. Pages 103–119 in M. Dicks and M. Monson, editors. Proceedings of the NC163 Post-CRP Land-use Conference. Great Plains Agricultural Policy Center, Oklahoma State University, Stillwater, USA.

Carroll, S. C., D. R. Rummel, and E. Segarra. 1993. Overwintering by the boll weevil (Coleoptera: Curculionidae) in Conservation Reserve Program grasses on the Texas High Plains. Journal of Economic Entomology 86:382–393.

Davison, W. B., and E. Bollinger. 2000. Predation rates on real and artificial nests of grassland birds. Auk 117:147–153.

Eggebo, S. L., K. F. Higgens, D. E. Naugle, and F. R. Quamen. 2003. Effects of CRP field age and cover type on ring-necked pheasants in eastern South Dakota. Wildlife Society Bulletin 31:779–785.

Evrard, J. O. 2000. The Conservation Reserve Program and duck and pheasant production in St. Croix County, Wisconsin. Wisconsin Department of Natural Resources Research Report 183.

Furrow, L. T. 1994. The influence of field age on mammalian relative abundance, diversity, and distribution on Conservation Reserve Program lands in Michigan. M.S. Thesis, Michigan State University, East Lansing, USA.

Gehring, T. M., and R. K. Swihart. 2004. Home range and movements of long-tailed weasels in a landscape fragmented by agriculture. Journal of Mammalogy 85:79–86.

Gould, J. H., and K. J. Jenkins. 1993. Seasonal use of Conservation Reserve Program lands by white-tailed deer in east-central South Dakota. Wildlife Society Bulletin 21:250–255.

Granfors, D. A., K. E. Church, and L. M. Smith. 1996. Eastern meadowlarks nesting in rangelands and Conservation Reserve Program fields in Kansas. Journal of Field Ornithology 67:222–235.

Greenfield, K. C., L. W. Burger, Jr., M. J. Chamberlain, and E. W. Kurzejeski. 2002. Vegetation management practices on Conservation Reserve Program fields to improve northern bobwhite habitat quality. Wildlife Society Bulletin 30:527-538.

———, M. J. Chamberlain, L. W. Burger, and ———. 2003. Effects of burning and discing Conservation Reserve Program fields to improve habitat quality for northern bobwhite (Colinus virginianus). American Midland Naturalist 149:344-353.

Hall, D. L., and M. R. Willig. 1994. Mammalian species composition, diversity and succession in Conservation Reserve Program grasslands. Southwestern Naturalist 39:1–10.

Haroldson, K. J., R. O. Kimmel, M. R. Riggs, and A. H. Berner. 1999. Association of ring-necked pheasant, gray partridge, and meadowlark abundance to CRP grasslands. Pages 10–17 in B. Joselyn, editor. Summaries of wildlife research findings 1998. innesota Department of Natural Resources. Wildlife Populations and Research Unit – Report 1998.

Herkert, J. R. 1997. Population trends of the Henslow's sparrow in relation to the Conservation Reserve Program in Illinois, 1975–1995. Journal of Field Ornithology 68:235–244.

———. 1998. The influence of the CRP on grasshopper sparrow population trends in the mid-continental United States. Wildlife Society Bulletin 26:227–231.

———. 2004. Grassland birds and the Conservation Reserve Program: early trends revisited. 65th Annual Midwest Fish and Wildlife Conference, 14 December 2004, Indianapolis, Indiana, USA.

———, D. W. Sample, and R. E. Warner. 1996. Management of midwestern grassland landscapes for the conservation of migratory birds. Pages 89–116 in F. R. Thompson, III, editor. Management of midwestern landscapes for the conservation of Neotropical migratory birds. U.S. Department of Agriculture, Forest Service, General Technical Report NC-187.

Hill, D. A., and P. A. Robertson. 1988. A population model as an aid to pheasant management. Pages 149–164 in D. L. Hallett, W. R. Edwards, and G. V. Burger, editors. Pheasants: symptoms of wildlife problems on agricultural lands. North Central Section, The Wildlife Society, West Lafayette, Indiana, USA.

Horn, D. J., R. R. Koford, and M. L. Braland. 2002. Effects of field size and landscape composition on grassland birds in south-central Iowa. Journal of the Iowa Academy of Science 109:1–7.

Hughes, J. P., and P. S. Gipson. 1996. Perceptions of wildlife damage by Conservation Reserve Program contract holders in Riley County, Kansas. Pages 154–157 in R. M. Timm and A. C. Crabb , editors. Proceedings of the 17th Vertebrate Pest Conference. University of California, Davis, USA.

Hughes, J. P., R. J. Robel, and K. E. Kemp. 2000. Factors influencing mourning dove nest success in CRP fields. Journal of Wildlife Management 64:1004–1008.

———, ———, ———, and J. L. Zimmerman. 1999. Effects of habitat on dickcissel abundance and nest success in Conservation Reserve Program fields in Kansas. Journal of Wildlife Management 63:523–529.

Hull, S. D., R. J. Robel, and K. E. Kemp. 1996. Summer avian abundance, invertebrate biomass, and forbs in Kansas CRP. Prairie Naturalist 28:1–12.

Hygnstrom, S. E., K. C. VerCauteren, and J. D. Ekstein. 1996. Impacts of field-dwelling rodents on emerging field corn. Pages 148–150 in R. M. Timm and A. C. Crabb , editors. Proceedings of the 17th Vertebrate Pest Conference. University of California, Davis, USA.

Kamler, J. F., W. B. Ballard, E. B. Fish, P. R. Lemons, K. Mote, and C. C. Perchellets. 2003. Habitat use, home ranges, and survival of swift foxes in a fragmented landscape: conservation implications. Journal of Mammalogy 84:989–995.

King, J. W., and J. A. Savidge. 1995. Effects of the Conservation Reserve Program on wildlife in Southeast Nebraska. Wildlife Society Bulletin 23:377–385.

Klute, D. S., and R. J. Robel. 1997. Will conversion of Conservation Reserve Program (CRP) lands to pasture be detrimental for grassland birds in Kansas? American Midland Naturalist 137:206–212.

Maddox, J. D., and E. K. Bollinger. 2000. Male dickcissels feed nestlings in east-central Illinois. Wilson Bulletin 112:153–155.

McCoy, T. D. 1996. Avian abundance, composition, and reproductive success on Conservation Reserve Program fields in northern Missouri. M.S. Thesis, University of Missouri-Columbia, USA.

———, M. R. Ryan, and L. W. Burger, Jr. 2001. Grassland bird conservation: CP1 vs. CP2 plantings in Conservation Reserve Program fields in Missouri. American Midland Naturalist 145:1–17.

———, ———, E. W. Kurzejeski, and L. W. Burger, Jr. 1999. Conservation Reserve Program: source or sink habitat for grassland birds in Missouri? Journal of Wildlife Management 63:530–538.

McIntyre, N. E. 2003. Effects of Conservation Reserve Program seeding regime on harvester ants (Pogonomyrmex), with implications for the threatened Texas horned lizard (Phrynosoma cornutum). Southwestern Naturalist 48:274–313.

McIntyre, N. E., and T. R. Thompson. 2003. A comparison of Conservation Reserve Program habitat plantings with respect to arthropod prey for grassland birds. American Midland Naturalist 150:291–301.

Merrill, M. D., K. A. Chapman, K. A. Poiani, and B. Winter. 1999. Land-use patterns surrounding greater prairie-chicken leks in northwestern Minnesota. Journal of Wildlife Management 63:189–198.

Millenbah, K. F. 1993. The effects of different age classes of fields enrolled in the Conservation Reserve Program in Michigan on avian diversity, density, and productivity. M.S. Thesis, Michigan State University, East Lansing, USA.

Morris, K. 2000. Avian abundance and diversity in CRP, crop fields, pastures, and restored and native grasslands during winter. Passenger Pigeon 62:217–224.

Mueller, J. M., K. J. Harolson, A. H. Berner, and R. O. Kimmel. 2000. Wildlife response to the Conservation Reserve Program in Minnesota. Pages 27–30 in A. H. Berner, editor. Summaries of Wildlife Research Findings 1999. Minnesota Department of Natural Resources, Wildlife Populations and Research Unit, Report 1999.

Murphy, M. T. 2003. Avian population trends within the evolving agricultural landscape of eastern and central United States. Auk 120:20–34.

Murray, L. D., and L. B. Best. 2003. Short-term bird response to harvesting switchgrass for biomass in Iowa. Journal of Wildlife Management 67:611–621.

———, ———, T. J. Jacobsen, and M. L. Braster. 2003. Potential effects on grassland birds of converting marginal cropland to switchgrass biomass production. Biomass and Bioenergy 25:167–175.

Olsen, R. A., and M. J. Brewer. 2003. Small mammal populations occurring in a diversified winter wheat cropping system. Agriculture, Ecosystems and Environment 95:311–319.

Patterson, M. P., and L. B. Best. 1996. Bird abundance and productivity in Iowa CRP fields: the importance of vegetation structure and composition. American Midland Naturalist 135:153–167.

Peterjohn, B. G. 2003. Agricultural landscapes: Can they support healthy bird populations as well as farm products? Auk 120:14–19.

Phillips, S. A., C. M. Brown, Jr., and C. L. Cole. 1991. Weeping lovegrass, Eragrostis curvula (Schrader) Nees von Esenbeck, as a harborage of arthropods on the Texas high plains. Southwestern Naturalist 36:49–53.

Riley, T. Z. 1995. Association of the Conservation Reserve Program with ring-necked pheasant survey counts in Iowa. Wildlife Society Bulletin 23:386–390.

———. 2004. Private-land habitat opportunities for prairie grouse through federal reserve conservation programs. Wildlife Society Bulletin 32:83–91.

Robel, R. J., J. P. Hughes, T. D. Keane, and K. E. Kemp. 2003. Do artificial nests reveal meaningful patterns of predation in Kansas grasslands? Southwestern Naturalist 48:460–464.

Rodgers, R. D. 1999. Why haven't pheasant populations in western Kansas increased with CRP? Wildlife Society Bulletin 27:654–665.

Roseberry, J. L., and L. M. David. 1994. The Conservation Reserve Program and northern bobwhite population trends in Illinois. Transactions of the Illinois State Academy of Science 87:61–70.

Ryan, M. R. 2000. Impact of the Conservation Reserve Program on wildlife conservation in the Midwest. Pages 45–54 in W. L. Hohman and D. J. Halloum, editors. A comprehensive review of Farm Bill contributions to wildlife conservation, 1985–2000. U.S. Department of Agriculture, Natural Resources Conservation Service, Wildlife Habitat Management Institute, Technical Report USDA/NRCS/WHMI-2000.

———, L. W. Burger, and E. W. Kurzejeski. 1998. The impact of CRP on avian wildlife: a review. Journal of Production Agriculture 11:61–66.

Sauer, J. R., S. Schwartz, B. G. Peterjohn, and J. E. Hines. 1996. The North American Breeding Bird Survey home page. Version 94.3. Patuxent Wildlife Research Center, Laurel, Maryland, USA.

Selting, J. P., and L. R. Irby. 1997. Agricultural land use patterns of native ungulates in south-eastern Montana. Journal of Range Management 50:338–345.

Svedarsky, W. D., R. L. Westemeier, R. J. Robel, S. Gough, and J. E. Toepher. 2000. Status and management of the greater prairie-chicken Tympanuchus cupido pinnatus in North America. Wildlife Biology 6:277–284.

Swanson, D. A., D. P. Scott, and D. L. Risley. 1999. Wildlife benefits of the Conservation Reserve Program in Ohio. Journal of Soil and Water Conservation 54:390–394.

Toepfer, J. E. 1988. Ecology of the greater prairie chicken as related to reintroductions. Dissertation, Montana State University, Bozeman, USA.

[USDA] U.S. Department of Agriculture. 2003. Highlights of expected Conservation Reserve Program (CRP) changes for 2003 and beyond. U.S. Department of Agriculture, Natural Resources Conservation Service, National Bulletin 300-3-4. <http://policy.nrcs.usda.gov/scripts/lpsiis.dll/NB/NB_300_3_4.htm>. Accessed 2005 Jun 24.

———. 2005. Conservation Reserve Program monthly summary—January 2005. U.S. Department of Agriculture, Farm Service Agency, CRP contract summary and statistics. <http://www.fsa.usda.gov/dafp/cepd/crp_statistics.htm>. Accessed 2005 Jun 24.

Warner, R. E., P. C. Mankin, L. M. David, and S. L. Etter. 1999. Declining survival of ring-necked pheasant chicks in Illinois during the late 1900s. Journal of Wildlife Management 63:705–710.

Weber, W. L., J. L. Roseberry, and A. Woolf. 2002. Influence of the Conservation Reserve Program on landscape structure and potential upland wildlife habitat. Wildlife Society Bulletin 30:888–898.