Appendix II: An Annotated Bibliography for Wildlife Responses to the Conservation Reserve Program

Arthur W. Allen
USGS, Biological Resources Division
Midcontinent Ecological Science Center
4512 McMurry Ave.
Fort Collins, CO 80525
Telephone: 970-226-9312; e-mail: art_allen@usgs.gov

The following bibliography provides brief summaries of research products examining the effects of the Conservation Reserve Program and agricultural policies on wildlife and their habitats. The summaries below provide only general overviews; therefore, users are urged to review reports in their entirety to obtain a more thorough understanding of results and recommendations. Citations without annotations were not reviewed.

Allen, A. W. 1993. Wildlife habitat criteria in relation to future use of CRP lands. Pages 41-88 *in* Proceedings of the Great Plains Agricultural Annual Meeting, June 2-4, 1993. Rapid City, South Dakota.

Report, based on input solicited from state and federal biologists, identified strengths and weaknesses of the CRP as wildlife habitat. Information was presented on relationships between the CRP, specific conservation practices, spatial considerations, planning, and management. Need was identified for explicit definitions of CRP/wildlife objectives on regional and local scales.

Allen, A. W. 1994a. Regional and state perspectives on Conservation Reserve Program (CRP). U.S. Fish and Wildlife Service Federal Aid Report, National Biological Survey, National Ecology Research Center, Fort Collins, Colorado. 28 pp.

Literature review and information furnished by state and federal biologists on regional effects of CRP on wildlife in agricultural ecosystems. Needs of endemic grassland species and other wildlife species more traditionally associated with agricultural land use were compared. Recommendations included: (1) need for elevated involvement of state wildlife agencies in technical assistance to USDA agencies and contractees, (2) increased flexibility in conservation practices implemented, and (3) greater recognition of regional and local priorities.

Allen, A. W. 1994b. Conservation Reserve Program (CRP) contributions to avian habitat. U.S. Fish and Wildlife Service Federal Aid Report, National Biological Survey, National Ecology Research Center, Fort Collins, Colorado. 19 pp.

Summary of CRP contributions to distribution and quality of habitat for game and nongame birds associated with agricultural ecosystems. Report concentrates largely on species endemic to grassland ecosystems. Author discussed characteristics of CRP contracts with greatest potential benefits, landscape planning, and management recommendations.

Allen, A. W. 1994c. Wildlife benefits of the Conservation Reserve Program: a national perspective. Pages 18-20 *in* When Conservation Reserve Program contracts expire: The policy options. Soil and Water Conservation Society, Ankeny, Iowa.

The author provided a concise synopsis of the wildlife benefits of CRP. He attributed improved reproductive success and expanded distribution of several grassland bird species to the establishment of CRP grasslands. The article reported that nest success of upland-nesting waterfowl on CRP land was higher than on established waterfowl production areas. He discussed how the pattern of CRP land distribution within a watershed would influence wildlife. The author concluded that agricultural policies and environmental concerns can be compatible and result in public benefits on a national scale.

Allen, A. W. 1994d. Wildlife benefits of the Conservation Reserve Program: A national perspective. Land and Water: Magazine of Natural Resources and Restoration 38:23-25.

See Allen (1994c). Above article published by magazine to reach wider audience.

Allen, A. W. 1995a. Agroforestry and wildlife: alternatives and opportunities. Pages 67-73 *in* W. J. Rietveld, editor. Proceedings of Agroforestry, Sustainable Agriculture Symposium. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-GTR-261.

Author presented spatial design considerations of tree-dominated cover types within agricultural ecosystems to benefit selected species of wildlife. He discussed potential negative effects of tree/shrub-dominated covers to endemic avian grassland species.

Allen, A. W. 1995b. Agricultural ecosystems. Pages 423-426 *in* E. T. LaRoe, G. S. Farris, E. E. Puckett, P. D. Doran, and M. J. Mac, editors. Our living resources: A report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. U.S. Department of the Interior, National Biological Service, Washington, D.C.

Author summarized historical effects of agricultural production on quality and distribution of wildlife habitats. He presented preliminary results of multi-state monitoring effort to describe grassland characteristics in undisturbed CRP fields in the southern Plains and Midwest. He discussed potential benefits of CRP for wildlife populations associated with agriculturally dominated landscapes.

Allen, A. W., Y. K. Bernal, and R. J. Moulton. 1996. Pine plantations and wildlife in the southeastern United States: An assessment of impacts and opportunities. U.S. Department of Interior, National Biological Service. Information and Technology Report 3. 32 pp.

Report documented the nation's growing dependence on southeastern forest products and the major role that private lands will play in provision of timber resources in future decades. Nontimber-related financial investment, recreation, and aesthetic considerations increasingly define acceptable management goals for owners of nonindustrial private forestland (NIPF). Wildlife was the principal factor affecting management on a growing number of privately owned forest lands. Author projected that within the next 50 years, the area of even-aged pine plantations, including CRP, on southeastern NIPF lands will exceed 20 million acres. Silvicultural prescriptions applied to forestlands will influence wildlife habitat quality within as well as across stand boundaries and may potentially influence habitat distribution on a landscape scale. Various alternatives in physical design, location, and subsequent management of pine plantations were presented to mitigate negative effects of even-aged forest management on wildlife.

Allen, A. W., B. S. Cade, and M. W. Vandever. In press. Effects of emergency haying on vegetative characteristics within selected Conservation Reserve Program fields in the northern Great Plains. Journal of Soil and Water Conservation. In press.

Study compared vegetative characteristics of undisturbed and hayed CRP fields in North and South Dakota in 1999. Fields used in the study were of the same age and planted with similar mixes of cool-season, introduced grasses and forbs. Emergency haying had little long-term effect on vegetation height/density, percent cover of live grass, or forb cover when compared to undisturbed fields. The presence of legumes (primarily alfalfa) increased in response to haying, whereas abundance of noxious weeds (primarily Canada thistle) decreased. Implications for long-term management of CRP grasslands to meet avian habitat requirements were discussed.

Allen, K. 1990. Reflections on the past, challenges for the future: An examination of U.S. agricultural policy goals. Pages 3-23 *in* K. Allen, editor. Agricultural policies in a new decade. Resources for the future. Washington, D.C.

The development of agricultural policy has become a process of mutual accommodation with large numbers of narrow provisions being fitted together to become broad-based legislation often containing inconsistencies and few clues to real goals of policy. Agricultural policy is forced to address many more issues than farm prices and incomes. Food, fiber, trade, environmental health, rural macroeconomic, and foreign policies have all become important constituents in formulation of agricultural policies. Main objective of farm groups remains price and income support, market stability. Overall goals have broadened in response to a political environment in which there is an increasing awareness among nonfarm interests that agricultural programs have been partly responsible for detrimental effects on the environment.

Consumer interests will become increasingly important to the largely urban Congress. Demographic changes in population will continue to cause changes in consumers' tastes and preferences. Concerns about chemical residues in foods and their injection into the environment are a major issue and will continue to be so. The public wants to provide support for farmers but are increasingly disenchanted with subsidies that go largely to the largest, wealthiest farmers. Rural economies: Farming and agricultural service industries together contributed only about 8% of the personal income in nonmetropolitan areas in 1986. Raising farm prices for select agricultural commodities is an inefficient way to promote rural economic activity. Economically diversified rural

communities can offer greater employment opportunities to farmers who wish to continue farming but who also have difficulties meeting financial commitments. Small, marginal changes can yield significant results in the long-run. Long-term goal of agricultural policies should be promotion of a healthy, competitive, and diverse agricultural sector and viable, diverse rural communities.

Allen, P., D. Van Dusen, J. Lundy, and S. Gliessman. 1991. Integrating social, environmental, and economic issues in sustainable agriculture. American Journal of Alternative Agriculture 6:34-39.

Review of popular definitions of sustainable agriculture indicated that focus was primarily on farm-level resource conservation and profitability as main components of sustainability. Authors proposed an expanded understanding of sustainability that focuses on entire food and agricultural system at global level and includes environmental soundness, economic viability, as well as social equity.

Altieri, M. A. 1990. How best can we use biodiversity in agroecosystems? Outlook on Agriculture 20:15-23.

Anderson, R. E. 1991. Wisconsin wetlands restored. Soil and Water Conservation News 12:14.

Author described wetland restorations in CRP fields in Wisconsin. In a two-year period, 110 wetlands were restored on CRP lands. Author reported wildlife occurrences on the sites.

Anderson, W. L., and L. M. David. 1992. Results of the 1991-1992 Illinois quail hunter survey. Illinois Department of Conservation, Division of Wildlife Resources Administrative Report. Chicago. 17 pp. + appendices.

Anderson, W. L., and L. M. David. 1992. Results of the 1991-1992 Illinois pheasant hunter survey. Illinois Department of Conservation, Division of Wildlife Resources Administrative Report. Chicago. 16 pp. + appendices.

Angelstram, P. 1986. Predation on ground-nesting birds' nests in relation to predator densities and habitat edge. Oikos 47: 365-373.

General discussion of how predators utilize different habitats. As the size of habitat areas decreases, the influences of surrounding cover become increasingly important. Since relative amount of edge increases as patch size decreases, the predation rate should be inversely related to the size of the patch. High densities of generalist predators are often a consequence of human activities (agriculture). Edges in more productive habitats will experience greater predation than edges in less productive habitats

Angermeier, P. L., and J. R. Karr. 1994. Biological integrity versus biological diversity as policy directives. Bioscience 44:690-697.

Biological integrity refers to a system's wholeness, including presence of all appropriate elements and processes at appropriate rates. Diversity is collective property of system elements. Unlike diversity, which can be expressed as the number of kinds of items, integrity refers to condition. High integrity reflects natural evolutionary and biogeographic processes. The value of many artificial, human-generated landscapes, such as agricultural landscapes, depends on naturally evolved elements and processes (e.g., nitrogen-fixing bacteria and soil formation). Attempts to reconstruct desirable biotic conditions must proceed with the best information currently available. Ineffective policy that emphasizes piecemeal conservation rather than comprehensive protection has been unsuccessful. Focus of policy formulation should be protection of processes that generate and maintain all elements. Policy effectiveness also could be improved by shifting focus from populations and species to landscapes.

Ball, I. J., R. J. Eng, and S. K. Ball. 1995. Population density and productivity of ducks on large grassland tracts in north-central Montana. Wildlife Society Bulletin 23:767-773.

Analysis of variation in duck productivity associated with block size and effects of the presence of red fox versus coyotes. Productivity of dabbling ducks on large grassland tracts with relatively low populations of predators was higher than recorded where habitat fragmentation and high populations of predators supported by alterations in habitat were more severe.

Attempts to improve nest success at an inappropriately small scale may be counterproductive if hens and predators are attracted to same limited area. Increasing surface water area in areas where rates of nest success are low, attracts pairs to situations where mortality exceeds recruitment. Due to foraging strategies and prey preferences, productivity of dabbling ducks can be expected to be higher in large grassland tracts where coyotes are primary predator. More fragmented habitats where red fox is dominant predator can be expected to have lower waterfowl productivity.

Baker, B. 2000. Farm Bill environmental program may threaten native prairie habitat. Bioscience 50:400.

Description of potential detrimental consequences of CRP due to extensive use of crested wheatgrass in Northwest and failure of USDA conservation provisions to prohibit sodbusting. Although crested wheatgrass furnishes erosion control and was recommended for establishment in a drought period, negative aspects of the planting include establishment of monocultures, limited value to wildlife, and invasion of the species into remaining stands of native prairie. Current USDA policies advocate planting of native grasses. Farmers who intend to plant invasive species are now less likely to be accepted or have contracts renewed in CRP. Currently, there are no restrictions on breaking out native grasslands for crop production while enrolling existing cropland into CRP. The landowner's incentive for putting grassland into crops presumably is better production in newly tilled land. Issue appears to be restricted to northern Great Plains where cropland acres increased by 708,000 acres during first 10 years of CRP.

Barbarika, A., T. Osborn, and R. Heimlich. 1994. Using an environmental index in the Conservation Reserve Program. Pages 118-133 *in* Proceedings of the NCT-163 Post Conservation Reserve Program Land Use Conference, January 10-11, 1994. Denver, Colorado.

Barker, J. R., G. A. Baumgarder, D. P. Turner, and J. J. Lee. 1996. Carbon dynamics of the Conservation and Wetland Reserve Programs. Journal of Soil and Water Conservation 51:340-346.

Analysis of Conservation and Wetland Reserve Programs to quantify carbon (C) dynamics of cropland conversion to grassland or forestland. Cropland converted to forestland gained C at a rate about 7-times greater than cropland converted to grassland. Maintaining existing CRP grassland will provide substantial C sequestration on a national scale due to large area enrolled in long-term set-aside.

Barnes, T. G., L. A. Madison, J. D. Sole, and M. J. Lacki. 1995. An assessment of habitat quality for northern bobwhite in tall fescue-dominated fields. Wildlife Society Bulletin 23:231-237.

Evaluation of tall fescue (*Festuca arundinacea*) fields in Kentucky. Fields characterized by dense vegetation, little bare ground, and low plant species diversity. Tall fescue characterized as marginal habitat for bobwhite quail due to unsuitable vegetation structure, floristic composition, and insufficient food. Tall fescue is grown extensively for stock feed, turf, and conservation purposes. It is an excellent pasture grass and the dominant grass seeded in most southeastern CRP fields. Aggressive domination of fields by tall fescue may reduce plant species diversity resulting in lower quality of habitat. Infection of endophytic fungus (*Acremonium coenophialum*) may result in fescue toxicosis, reproductive disorders in mammals, and reduced fertility and hatching success in quail have been documented.

Basore, N. S., L. B. Best, and J. B. Wooley. 1986. Bird nesting in Iowa no-tillage and tilled cropland. Journal of Wildlife Management 50:19-28.

Analysis of bird nesting in Iowa no-tillage and tilled croplands. Bird densities greater in no-till fields than in tilled fields. Vegetation residue was important for attracting birds to no-till fields; nest destruction by farming implements in no-till fields was infrequent compared to tilled fields. No-till fields had nest density of 36 nests/100 ha compared to four nests/100 ha in tilled fields. Nests in tilled fields were in locations where there was residual vegetation.

Beauchamp, W. D., R. R. Koford, T. D. Nudds, R. G. Clark, and D. H. Johnson. 1996. Long-term declines in nest success of prairie ducks. Journal of Wildlife Management 60:247-257.

Analysis of mallard, northern pintail, gadwall, blue-winged teal, and northern shoveler nesting success in Prairie Pothole Region of Canada and United States, 1935-1992. Nest success was higher in late than in early nesting species but declined in all species at similar rate. Time explained only 10% of variation in nest success; precipitation did not account for additional explained variation. Population declines in mallard, northern pintail, and blue-winged teal coincide with temporal declines in nest success.

Berg, N. A. 1994. The genesis of the CRP. Part 1: evolution of the CRP. Pages 7-12 *in* When Conservation Reserve Program contracts expire: The policy options. Soil and Water Conservation Society, Ankeny, Iowa.

History of land set-aside programs leading up to creation of CRP. Major factors contributing to passage of 1985 Farm Bill were (1) need for revamping of agricultural policy, (2) spiraling farm program costs, (3) poor farm economy, (4) destructiveness of existing agricultural policies, and (5) recognition of nonagricultural stakeholders.

Berner, A. H. 1984. Federal land retirement program: A land management albatross. Transactions of the North American Wildlife and Natural Resources Conference 49:118-130.

Acreage reduction portion of Soil Bank and Feed Grain Program did not require seeding of grass-legumes on retired acres. Annual programs emphasized administrative flexibility in commodity control to the detriment of soil and wildlife conservation. Most acres in these programs were fallow or disked by the end of July to the detriment of both game and nongame species. Agricultural Stabilization and Conservation Service (ASCS) regulations required that most fields be planted late (after June 15) and covers be destroyed by mowing, disking, or plowing before grain matured (usually mid-July). Before 1985, land retirement programs were narrow in scope, dealing exclusively with controlling production of domestic commodities. Policies tended to encourage conversion of

noncropland to cropland even if those lands were highly erodible. Additionally, uncertainties about program structure made planning difficult, so farmers tended to prepare all acres for planting.

Author concluded that annual land retirement programs (1961-1983) aggravated soil erosion and wildlife habitat problems and encouraged unwise use of land. To reduce soil erosion and provide secure habitat for wildlife associated with farmland landscapes, he recommended that set-aside program provide long-term retirement options and require seeding with perennial grass-legume mixture.

Berner, A. H. 1988. Federal pheasants - impact of federal agricultural programs on pheasant habitat, 1934-1985. *In* Pheasants: Symptoms of wildlife problems on agricultural lands.

Review of pheasant responses to federal agricultural programs. Federal agricultural programs designed to assist farmers through cropland diversion and deficiency payment programs significantly impacted the amount and quality of pheasant habitat between 1934 and 1985. Pheasants responded positively to multi-year cropland diversion programs, but they responded negatively to annual cropland set-aside programs that allowed poor cover management and required periodic disturbance. Potential of annual set-aside programs such as the Feed Grain (FGP) and Wheat Production Programs (WHP) for providing safe nesting and brood-rearing cover for pheasants was limited by early destruction of cover before seed head development. In Minnesota, set-aside programs had a pronounced negative effect on pheasants. Under these programs a majority of fields were fallowed or lightly seeded to small grain in early June and destroyed by July 15. Nesting cover was absent, poor, or fair on about 80% of set-aside lands and good to excellent on only about 20% of set-aside lands. Hunting cover and winter cover were rated about 4.4% fair, 7.4% good, and 2.8% excellent. Proper management of these lands could greatly benefit game and nongame populations.

Berner, A. H. 1989. The 1985 Farm Act and its implications for wildlife. Pages 437-465 in 1988/1989 Audubon wildlife report. National Audubon Society, New York.

Changes in land use and agricultural production significantly affected wildlife inhabiting agricultural landscapes between 1934 and 1985. Specialization and intensification of agricultural production were responsible for severe declines in many populations of wildlife. Federal commodity programs contributed to much of the decline in habitat quality and availability. The 1934 Cropland Adjustment Act was the first retirement program with the purpose of stabilizing the market and farm economy. Planting of cover on retired acres was not required. The 1936 Agriculture Conservation Program created SCS and ASCS and required farmers to plant grass or grass-legume cover on set-aside lands. Soil Bank established in 1956 provided annual to 10-year set-aside (Conservation Reserve) options.

Wildlife benefits of set-asides were limited by the short duration of contracts, frequency and timing of disturbances, wide variety of agricultural management practices implemented, and lack of technical guidance. Additionally, local guidance was left to the state or county committees comprised of area farmers which, many times, resulted in environmentally questionable management practices. For example, many committees allowed late seeding of cover crops or required no plant cover and permitted or required destruction of established cover in the fall.

During the period of 1956-1987, low prices for crops precipitated by overproduction resulted in low farm income. Subsidy programs were implemented to stabilize farm economy and increase farm income. USDA subsidy programs produced conflicting results, i.e., conversion of noncropland to cropland that contributed to an increase in the crop base and higher program costs.

ARP (acreage reduction programs) paid farmers to annually idle land to reduce production of commodity crops. Regulations that once required reducing soil loss to “T,” now allow highly erodible croplands to be farmed under an approved conservation plan that addresses soil loss. USDA predicted that crop surpluses will exist at least through 2000. More than 20 million acres/yr were expected to be retired in ARP. Because ARP agreements were annual, farmers were unwilling to pay to seed perennial grass-legume cover crops. ASCS committees generally opted to maintain maximum flexibility in establishing cover requirement, crop seeding dates, and rates and dates of cover destruction with minimal natural resource benefits.

Pheasant populations substantially increased when ARP acres were planted early to annual cover crops (typically small grains) and maintained to multi-year covers. However, ARP encouraged some practices that were detrimental to wildlife. Pheasant production in Minnesota was 30% lower in years with an ARP compared to years without the program. Author suggested that negative impacts could be reversed if set-aside acres were seeded to annual cover crop (small grains) and not disturbed for 90 days. In areas where winter cover may be critical, ARP should be seeded to cover crop such as forage sorghum and left undisturbed throughout winter. Cover for three or more years would provide maximum benefits.

Berner, A. H. 1994. Wildlife and federal cropland retirement programs. Pages 70-75 *in* When Conservation Reserve Program contracts expire: The policy options. Soil and Water Conservation Society, Ankeny, Iowa.

Review of studies of wildlife responses to cropland retirement programs from 1956 to 1984. Author recommended that future cropland retirement programs have the following features: (1) adequate technical assistance and cost share, (2) long-term retirement option and management assistance for environmentally sensitive areas, (3) multi-year (> 3 yrs) set-aside that emphasizes crop rotation and forage reserve objectives, (4) annual set-asides that protect soil, water, and wildlife, and (5) broader public representation of county and state technical committees. Recommended program would be decoupled from commodity control with incentives for sound land management (i.e., stewardship payments).

Berthelsen, P. S. 1989. Value of the Conservation Reserve Program to birds in the Texas southern High Plains. M.S. thesis. Texas Tech University, Lubbock. 106 pp.

Author stated that the greatest potential benefit of the CRP to wildlife in the southern High Plains was provision of secure, high quality nesting and winter cover for avian species. Bird species composition on CRP lands was represented primarily by two to three dominant species. Seven of 13 species observed on CRP lands were considered migrants or winter residents. Fields of blue grama/Kleingrass (BG/K) had the greatest avian winter densities, avian biomass estimates, nest densities, number of birds observed, and winter cover quality for pheasants. Compared to BG/K, bird use was reduced in blue grama/side-oats grama and blue grama/plains bluestem mixes.

Nest success on CRP lands averaged 22%; no apparent difference in nest success between CRP cover types. Earlier initiation of pheasant nests in CRP compared to surrounding area attributed to increased availability of nesting habitat, favorable weather, or hens entering breeding season in good physiological condition. CRP lands enabled nesting pheasants to disperse from margins of playa wetlands that were often flooded. Approximately one-third of fields evaluated were hayed or mowed for weed control resulting in minimal to no value as beneficial habitat for upland nesting birds. Mowing of CRP fields for weed control was unnecessary. As stands aged, grasses out-competed forbs. Weed control further reduced vegetative diversity in CRP fields.

Berthelsen, P. S., and L. M. Smith. 1995. Nongame bird nesting on CRP lands in the Texas southern High Plains. Journal of Soil and Water Conservation 1995:672-675.

Authors determined nongame bird species composition, nest density, and nesting success in CRP fields planted to the three most common grass mixtures. The fields were planted in 1987 and field work was conducted in 1988 and 1989. The average nest densities of the birds found using the CRP fields decreased or remained similar between 1988 and 1989. Overall nest success was 40.5 percent. Authors speculated that as CRP cover types aged, their value as nongame bird habitat may decline. However, they concluded that increases in CRP fields in the southern High Plains were improving habitat for nongame birds, since few of these species nest in cropland.

Berthelsen, P. S., L. M. Smith, and C. L. Coffman. 1989. CRP land and game bird production in the Texas High Plains. Journal of Soil and Water Conservation 44:504-507.

Determination of cover types, acreages, establishment success, and establishment costs for CP1, CP2, CP4, CP10, and CP12 in southern High Plains of Texas. Estimated that annual production for selected practices was 174,000 pheasant chicks and 1,400 ducklings. Noted that CRP benefits for waterfowl were limited by availability of water.

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. Proceedings of the North American Wildlife and Natural Resources Conference 55:46-56.

Study conducted in southern High Plains of Texas in 1988-1989 compared pheasant nest success on CRP and cropland, estimated production and recruitment rates for pheasants in selected CRP grass mixes (blue grama/side-oats grama, blue grama/Kleingrass, and blue grama/plains bluestem), and provided management recommendations. Annual estimates of pheasant nest density, nest success, clutch size, and egg hatchability, and vegetative structure were provided by seeding mixture. Blue grama/Kleingrass mixture had greatest avian nest density, and pheasant nest density, success, and productivity. Wildlife benefits were reduced on one-third of study sites that were hayed.

Best, L. B., H. Campa III, K. E. Kemp, R. J. Robel, M. R. Ryan, J. A. Savidge, H. P. Weeks Jr., S. R. Winterstein. 1998. Avian abundance in CRP and crop fields during winter months in the Midwest. American Midland Naturalist. 139:311-324.

Avian abundance and nesting success were compared in Conservation Reserve Program (CP1 and CP2) and rowcrop fields in six midwestern states (Indiana, Iowa, Kansas, Michigan, Missouri, and Nebraska), 1991-1995. Number of species was similar in two habitats but abundance was 1.4 to 10.5 times greater in CRP fields. Additionally, number of nesting species was > 3 times greater and nest density was 13.5 times greater in CRP fields. Authors concluded that CRP provided many benefits for grassland birds, including several species of special concern.

Best, L. B., H. Campa III, K. E. Kemp, R. J. Robel, M. R. Ryan, J. A. Savidge, H. P. Weeks Jr., 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.

Comparison of abundance and nesting success of avian species in CRP and rowcrop fields over five years (91-95) in six Midwest states (Indiana, Kansas, Missouri, Michigan, Nebraska, and Iowa). Bird abundance 1.4 to 10.5 times greater in CRP than rowcrop. Nests of 33 bird species found in CRP with only 10 species in rowcrops; number of nests found 13.5 times greater in CRP. Nest success was 40% in CRP. Nest success in rowcrops similar to that of in CRP, but total number of nests found in rowcrop was 7.4% of that in CRP. Predation was greatest cause of nest failure. Long-term farm set-aside programs that establish perennial grass cover

provided many benefits for grassland birds, including several species for which conservation is a great concern. Authors recommended further investigation of species-specific habitat requirements in relation to planting, management, and spatial configuration of CRP.

Best, L. B., K. E. Freemark, J. J. Dinsmore, and M. Camp. 1993. A review and synthesis of habitat use by breeding birds in agricultural landscapes of Iowa. American Midland Naturalist 134:1-29.

Paper reviewed species composition, abundance, and nesting status of 144 birds in 20 habitats characteristic of Iowa's agricultural landscape. Density highest in linear habitats (railroad right-of-ways, wooded fencerows, and shelterbelts), lowest in rowcrop and small grain fields, and intermediate in natural habitats (upland and floodplain forest, marsh, and prairie). Species diversity predicted to increase with habitat diversity in landscape.

Best, L. B., R. C. Whitmore, and G. M. Booth. 1990. Use of cornfields by birds during the breeding season: The importance of edge habitat. American Midland Naturalist 123:84-99.

Study of breeding bird use of Iowa cornfields. A significant edge effect was detected with more bird species and about five-times more birds found in the perimeters of cornfields than in the centers of fields. Bird abundance in cornfields was greater along wooded edges than along herbaceous edges, suggesting that bird use of cornfields was influenced by adjacent habitat type. Authors concluded that shifts in land use practices resulting in increased field size and elimination of woody vegetation from edge habitats will affect both richness and abundance of avifauna associated with agricultural ecosystems.

Bjerke, K. 1991. An overview of the Agricultural Resources Conservation Program. Pages 7-10 *in* L. A. Joyce, J. E. Mitchell, and M. D. Skold, editors. The Conservation Reserve - yesterday, today, and tomorrow. U.S. Department of Agriculture, U.S. Department of Agriculture, Forest Service, General Technical Report RM-203. 64 pp.

Paper described three new features in the Food, Agriculture, Conservation, and Trade Act of 1990: Wetland Reserve Program, Agricultural Water Quality Incentives, and Environmental Easement Program. CRP accomplishments (1985-1990) were summarized in terms of acreage by conservation practice and economic benefits from improved water quality ($1.3-3.9 billion), recreation ($1.9-3.1 billion), and timber products ($3.3 billion).

Boatman, N. D., and N. W. Sotherton. 1988. The agronomic consequences and costs of managing field margins for game and wildlife conservation. Aspects of Applied Biology 17:47-56.

Removal of weeds, either through herbicides or mowing, decreases insect density and diversity associated with cereal crops. Increased use of herbicide in recent decades has removed host plants of many insects, and more recently, the use of insecticides has caused direct mortality of other species of insects. Consequently, there has been a reduction in the numbers and diversity of insect species which are the primary forage of early age class chicks of upland species.

Bock, C. E., V. A. Saab, T. D. Rich, and D. S. Dobkin. 1993. Effects of livestock grazing on Neotropical migratory landbirds in western North America. Pages 296-309 *in* D. M. Finch and P. W. Stangle, editors. Status and management of Neotropical migratory birds. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-229. 422 pp.

To enhance value of CRP grasslands to landowners, authors advocated moderate grazing by livestock or controlled haying of CRP. They argued that haying and moderate grazing of CRP, coupled with establishment of livestock exclosures on public lands, would enhance value of public rangelands for wildlife.

Bogenschutz, T. R. 1992. An evaluation of corn and sorghum as a winter food source for ring-necked pheasants. M.S. thesis. University of South Dakota, Brookings. 65 pp.

Corn and sorghum furnished higher quality winter food for pheasants than did natural wild foods and soybeans. Natural foods were high in fiber and low in digestible energy; soybeans contained trypsin, a digestive inhibitor that lowered the metabolizable energy content of the diet. Sorghum provided superior winter cover. Author recommended that food plots include both corn and sorghum. If winter cover is not limiting, corn is a better option. However, if winter cover is limiting, then sorghum food plots are recommended.

Bohning-Gaese, K, M. L. Taper, and J. H. Brown. 1993. Are declines in North American insectivorous songbirds due to causes on the breeding range? Conservation Biology 7:76-86.

Authors argued that decline in migratory songbird populations in North America were caused primarily by nest failure rather than winter habitat loss. Evidence was presented that predation had a major impact on population trends; terrestrial mammals were perhaps the most important nest predators. Low and open nests

were especially vulnerable to nest predation. Authors suggested that even a small effect of cowbird parasitism was enough to cause a negative replacement rate and population decline in songbird populations experiencing high predation rates.

Bolen, E. G., L. M. Smith, and H. L. Schramm Jr. 1989. Playa lakes: Prairie wetlands of the southern High Plains. Bioscience 39:615-623.

Playa lakes and wetlands significantly increased plant and animal diversity in an intensively cultivated landscape of the southern High Plains. Playas are closed systems with a vertebrate fauna dominated by birds. Lagomorphs also reach high densities in playa habitat. Playas developed for agriculture had greater water level fluctuation and lower insect production than unmodified basins. Playas that received irrigation runoff had increased interspersion of vegetation and open water resulting in higher habitat quality. Cultivation of playas decreased their value as wildlife habitat. Reduction of vegetation surrounding lakes influenced water quality. Establishment of pits reduced the abundance and diversity of emergent vegetation that require periodic drying. Phytoplankton was associated with aquatic macrophytes that were important for production of macroinvertebrates and forage for wintering waterfowl. Pits diminished value of lakes for waterfowl that prefer densely vegetated sites. Losses of littoral and island vegetation reduced waterfowl nesting habitat and reduced production of invertebrates and plant foods important to breeding and wintering waterfowl and shorebirds. Loss of tall emergent and woody vegetation reduced roosting and nesting habitat for other birds. Modified lakes held water during dry seasons and provided habitat during periods of drought. Nonetheless, wildlife benefits remained contingent on the extent of the modification and on the temporal aspects of water-level fluctuations.

Bollinger, E. K., and T. A. Gavin. 1989. Eastern bobolink populations: Ecology and conservation in an agricultural landscape. Pages 497-506 *in* J. M. Hagan III, and D. W. Johnston, editors. Ecology and conservation of Neotropical migrant landbirds. Smithsonian Inst. Press. Washington, D.C. 609 pp.

Authors determined that bobolink abundance was greatest in old hayfields (≥ 8 yr). Authors speculated that abundance increased exponentially with hayfield size because of reduced predation and cowbird parasitism. Densities of eastern meadowlarks, upland sandpipers, Henslow's sparrows, and grasshopper sparrows were all positively correlated with bobolink densities. Authors recommended that conservation practices designed for grassland birds should concentrate on creating or maintaining large habitat patches that resemble old hayfields. They specifically recommended (1) creation or maintenance of patches of relatively sparse grass-dominated cover with some broadleaf forbs and (2) control of woody vegetation.

Boutin, C., K. E. Freemark, and D. A. Kirk. 1999. Farmland birds in southern Ontario: Field use, activity patterns and vulnerability to pesticide use. Agriculture, Ecosystems and Environment 72:239-254.

Major determinants of bird distribution in agricultural land were (1) type of crops grown, (2) configuration and physical structure of noncrop habitat, and (3) frequency and extent of agricultural practices such as tillage, pesticide application, and harvest. The lack of data on avian use of cropland in different agricultural landscapes was a major obstacle in assessing the effects of agriculture in many areas of North America. Most species surveyed used edge habitat significantly more than expected. More arthropods were found in field edges than in interiors. Many field margins or herbaceous borders were either sprayed directly for control of pests or were subjected to spray drift. Spraying of edges further reduced biodiversity in agricultural landscapes that already were depauperate.

Bowen, B. E., and A. D. Kruse. 1993. Effects of grazing on nesting by upland sandpipers in south central North Dakota. Journal of Wildlife Management 57:291-301.

In central Great Plains, sandpipers nested in grazed fields rather than in ungrazed fields with tall vegetation; however, grazing during the late spring and early summer had a detrimental effect on reproduction. Authors recommended that grazing should be delayed until at least mid- to late June and that traditional season-long grazing from June to October should be avoided. Autumn grazing at high stocking rates may be an acceptable alternative.

Boyd, H. 1985. The large-scale impact of agriculture on ducks in the prairie provinces, 1956-81. Canadian Wildlife Service Progress Notes 149. 31 pp.

Brady, S. J. 1988. Potential implications of Sodbuster on wildlife. Transactions of the North American Wildlife and Natural Resources Conference 53:239-248.

Analysis of the effects of Sodbuster component of Highly Erodible Land provision of the Food Security Act of 1985 on wildlife. Assuming that most farmers will continue to participate in USDA farm programs, author suggested that provision will discourage conversion of highly erodible land to cropland, thereby benefiting wildlife by minimizing erosion and sedimentation, water quality degradation, and loss of habitat diversity and abundance. Further, greatest benefit will likely be reduced sediment delivery to aquatic ecosystems.

Brennan, L. A. 1991. How can we reverse the northern bobwhite population decline? Wildlife Society Bulletin 19:544-555.

Sharp, widespread declines in bobwhite populations since the 1970s were attributed to clean farming practices; forest management systems that maximize basal area; increasing farm size and elimination of weedy fencerows; conversion of marginal farmlands to pine plantations; and direct and indirect effects of pesticides. Indirect effects of pesticides on quail are poorly understood. Agricultural chemicals indirectly affect game population by suppressing arthropod populations that are key food resources for broods. Weeds provide food and feeding substrates that are essential for growth and development of chicks. Author concluded that potential for CRP to enhance habitat was far from being realized. He recommended curtailment of mowing during peak nesting season and periodic disturbance of CRP (e.g., strip-disking) to maintain annuals and forage production.

Brennan, L. A. 1993. Future directions for bobwhite quail and wildlife research in the southeastern United States. Proceedings of the 1993 Tall Timbers Game Bird Seminar. Tall Timbers Research Station. Tallahassee, Florida.

Author reported that arthropod abundance increased in response to burning and strip-disking. However, herbicides disrupted the food chain and limited populations. Specifically, widespread application of herbicides suppressed weeds and reduced availability of insect populations needed by bobwhite hens and chicks. He recommended modification of herbicide application to benefit bobwhites in the Southeast.

Brennan, L. A. 1993. Strategic plan for quail management and research in the United States: Introduction and background. Pages 160-169 *in* Quail III: National Quail Symposium. Kansas Department of Wildlife and Parks, Pratt.

Habitat management by the private sector is apparently having little broad-scale impact on bobwhite populations. Interest in quail is large and growing. Author emphasized the need for creative professional leadership to solve problems caused by changing land use patterns. Detrimental effects of federal agricultural policies include annual spring burning, summer mowing, cool-season grasses (e.g., tall fescue and brome), promotion of extensive pine monocultures, and lack of flexibility in management. Paper provided detailed recommendations for modification of federal agricultural policies to improve conditions for quail.

Bryan, G. G., and L. B. Best. 1991. Bird abundance and species richness in grassed waterways in Iowa rowcrop fields. American Midland Naturalist 126:90-102.

Study examined bird abundance and species richness in grassed waterways and rowcrop fields in Iowa. Grassed waterways located in cornfields and soybean fields were planted to smooth brome. Authors observed 48 bird species in waterways compared to 14 in croplands. Total bird abundance three-times greater in waterways than in croplands. No species were exclusive to croplands. Authors suggested that unmowed waterways provided important habitat for birds in mid- to late summer because other grass-dominated cover types had earlier been disturbed (e.g., mowing). Current mowing recommendation is to mow after July 15, but 53% of all species observed and all of the breeding species were at peak abundance in the waterways during July 4-22. Authors, therefore, recommended that waterways be mowed in late August or early September. Further, mowing should not be undertaken after mid-September because mowing would reduce the amount of winter cover and residual vegetation required for early spring nesting.

Bryant, F. C., and L. M. Smith. 1987. The role of wildlife as an economic input into a farming or ranching operation. Pages 95-98 *in* J. E. Mitchell, editor. Impacts of the Conservation Reserve Program in the Great Plains. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-158.

The economic return of wildlife to Texas landowners varies widely, but in some instances exceeds net revenue generated by livestock and cash crops. Authors argued that CRP provides High Plains and Rolling Plains farmers and ranchers an opportunity to enhance wildlife on their land and increase their income. Management recommendations were provided for improving CRP lands for ring-necked pheasant, lesser prairie chicken, waterfowl, and big game.

Bultsma, P. M. 1995. Ducks and CRP. Proceedings of the Annual Meeting of the Society of Range Management 48:9 (abstract only).

Burger, L. D., L. W. Burger Jr., and J. Faaborg. 1994. Effects of prairie fragmentation on predation on artificial nests. Journal of Wildlife Management 58:249-254.

Artificial nests placed in smaller prairies had greater depredation rates than those in larger prairies (37 vs 13.9%). Although highest predation rates were observed in smallest prairie size classes and prairie size had an effect on predation, proximity to woody cover was the most important factor affecting predation rates on artificial nests. High predation rates observed in small prairies were attributed to the increased proportion of area near woody cover. Authors concluded that the potential effects of prairie size and woody vegetation on success of ground-nesting birds should

be considered in decisions of acquisition and management of prairie habitats.

Burger, L. W. Jr., E. W. Kurzejeski, T. V. Dailey, and M. R. Ryan. 1989. Structural characteristics in CRP fields in northern Missouri and their suitability as bobwhite habitat. Transactions of the North American Wildlife and Natural Resources Conference 55:74-84.

Study of vegetative conditions on CRP lands in northern Missouri from 1986 to 1988 with discussion and recommendations concerning value of CRP lands as winter, nesting, and brood-rearing cover for bobwhite quail. Structural characteristics of vegetation, dominant vegetation types, and frequency of disturbance were examined in relation to year, conservation practice, and season. Authors concluded that (1) emergency haying of CRP contributed to decline in habitat quality, (2) year of establishment or age of field was major factor affecting a field's seasonal habitat value for quail (i.e., value of CRP fields as brood-rearing and roosting cover declined, while nesting cover improved from year 1 to year 3), and (3) vegetative cover and habitat quality varied among conservation practices (CP4 > CP2 > CP1). Authors recommended that mowing be restricted; portions of CRP fields be disturbed on three-year rotation to maintain early successional habitats; and management for diverse age-classes among CRP fields within quail home range.

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. Kansas Department of Wildlife and Parks, Pratt.

Evaluation of relative invertebrate abundance, biomass, and diversity in CRP fields planted to red clover/timothy, timothy, orchardgrass, tall fescue, warm-season grasses, orchardgrass/Korean lespedeza, and conventionally tilled soybeans. Fields planted to red clover/timothy mixture and dominated by red clover had highest levels of invertebrate abundance and biomass. Mean invertebrate abundance and biomass in CRP fields were four-times that of soybean fields. CRP fields could furnish high quality brood habitat for avian species if legumes are incorporated, or maintained, in CRP plantings.

Cable, T. T. 1991. Windbreaks, wildlife, and hunters. Pages 35-55 *in* J. E. Rodiek and E. G. Bolen, editors. Wildlife and habitats in managed landscapes. Island Press, Washington, D.C.

Author stated that even though their value was widely recognized, windbreaks continue to be lost and degraded. For example, annual loss of hedgerows in five midwestern states was estimated to be 0.6-3.1%. The importance of windbreaks varies according to needs of specific wildlife species, both residents and migrants. Less than 3% of the Great Plains is forested. Although woodland habitats are scarce, woodland birds account for 46% of avifauna in western Kansas. Windbreaks may provide reproductive, escape, and protective cover that is particularly important during severe winter weather. Shelterbelts also provide additional sources of food, both seed and insects. Number of species and individuals that were completely or partially insectivorous increased as the size of the windbreak increased. Windbreaks in agricultural landscape serve as travel corridors and dispersal habitat between riparian habitats and other wooded covers. Value of shelterbelts to wildlife typically a function of size, number of rows, plant diversity, and vegetation height. Author indicated that placement was better for wildlife if located in or adjacent to grain fields rather than grazed pasture. He cautioned that shelterbelts may result in higher rates of predation on ground nesting birds in vicinity of wooded cover.

Caithamer, D. F., and G. W. Smith. 1995. North American ducks. Pages 34-37 *in* E. T. LaRoe, G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac, editors. Our living resources: A report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. U.S. Department of the Interior, National Biological Service. Washington, D.C.

Authors summarized status and trends of breeding and wintering North American ducks between 1955 and 1993. Estimated annual numbers and trends (1984-1993) of ducks were presented based on midwinter and breeding surveys. Sources of variation in waterfowl numbers were discussed. Authors concluded that maintaining or increasing habitat was needed to stabilize or increase waterfowl numbers, and agricultural policies and practices can profoundly affect habitat availability in North America.

Camp, M., and L. B. Best. 1994. Nest density and nesting success of birds in roadsides adjacent to rowcrop fields. American Midland Naturalist 131: 347-358.

Evaluation of nest densities and nesting success of birds in roadsides in an intensively farmed area in central Iowa in 1990-1991. Data obtained for 120 nests of eight species in 34 roadside areas. Microhabitat of nests was described for red-winged blackbird, pheasant, gray partridge, and vesper sparrow. Recommended seeding native grasses and forbs, retaining fences, periodic burns to maintain vegetation vigor, and avoidance of mowing, except for shoulders.

Campa, H. III, and S. R. Winterstein. 1992. Wildlife and vegetative response to diverted agricultural land in Gratiot County, Michigan. Michigan State University, Department of Fisheries and Wildlife Annual Report. December 1992. 26 pp.

Study detected significant differences in % canopy cover, height, total canopy, % grass canopy, % litter cover among diverted agricultural fields, but none of these differences were consistently related to field age. Older fields tended to be characterized by a greater percentage cover of grass and litter. Younger fields tended to have greater forb and live canopy cover. Younger fields supported greater avian densities and diversities, but reproductive success was higher in older fields. Authors suggested that differences in reproductive success of birds in young and old fields were associated with vegetative structure and availability of suitable nesting sites.

Capel, S., B. Carmichael, M. Gudlin, and D. Long. 1995. Wildlife habitat needs assessment, Southeast region. Transactions of the North American Wildlife and Natural Resources Conference 60:288-299.

Authors proposed that 1995 Farm Bill should elevate wildlife to coequal status with soil, water, and commodity production control. Additionally, they recommended the following changes in farm program administration and policy: (1) fully activate state technical committees and include state natural resource agency representation; (2) FSA county committee system should be diversified to include state natural resource agency representation, and STC decisions should be binding on county committees; (3) funding should be provided to staff program areas with biologists; and (4) funding should be provided for farm conservation planning. Goals were presented for grassland, shrub-early successional, wetlands, forests, and aquatic habitats. Proposed Farm Bill strategy was outlined.

Carmichael, D. B. Jr. 1997. The Conservation Reserve Program and wildlife habitat in the southeastern United States. Wildlife Society Bulletin 25:773-775.

Author suggested that wildlife benefits associated with CRP were reduced in southeastern states compared to that in the Midwest and Great Plains. He argued that pine plantations and tall fescue provided only limited benefits to wildlife. Pine plantations created under CRP resulted in loss of early successional and agricultural habitats. Fescue forms dense sod that is impenetrable by smaller animals. Author provided recommendations to improve CRP.

Carroll, C. R. 1992. The interface between natural areas and agroecosystems. Pages 365-383 *in* C. R. Carroll, J. H. Vandermeer, and P. Rosset editors. Agroecology. McGraw-Hill, New York.

Author presented information on the effects of surrounding land uses on natural areas embedded in agricultural landscapes. Farming systems generate weedy phenotypes, including plants, animals, and pathogens that may become invaders of natural areas. Use of crops by some wildlife species may magnify their importance in ecosystems. For example, crows, bluejays, and raccoons, important predators on bird nests, have disproportionately benefited from agricultural expansion.

Natural areas may become fragmented within agricultural landscapes. Fragmentation increases boundary phenomena, resulting in exacerbation of edge impacts. Loss of natural areas generally means that remaining patches are increasingly isolated; consequently, recolonization is difficult, increasing likelihood of local extinctions. Most of these impacts are cumulative and proceed as a consequence of many independent decisions that are made without regard to possible combined effects. Author maintained that little attention has been given to analysis of long-term and broad scale effects of fragmentation.

In absence of active ecological management, most small natural areas begin to degrade and become less representative of the original ecosystem. Small sites typically require more management effort per unit area than is required for large areas. Long-term security of natural areas in agricultural landscape will strongly depend on the way that the land surrounding the natural area is used. Surrounding land uses must be economically sustainable, socially equitable, and explicitly linked with management objectives in the embedded natural area.

Factors that should be addressed in the design of agricultural buffer zones include:

(1) Design of agricultural areas should be explicitly related to the ecological management goals of the natural area.

(2) Activities and processes that degrade the habitat, such as invasion by weeds and fire, should be minimized.

(3) Buffer zone activities should be able to be modified to meet new contingencies. Programs should be flexible so that change can be made without drastically disrupting local economy.

(4) Buffers should not be sensitive to rapid change in market prices, rising production costs, or decreasing market returns.

(5) Buffers should not rely on intensive use of agrochemicals, fire, or other methods that may strongly impact nearby natural areas.

Castrale, J. S. 1985. Responses of wildlife to various tillage conditions. Transactions of the North American Wildlife and Natural Resources Conference 50:142-156.

Evaluation of minimum tillage practices on wildlife use of agricultural fields, primarily corn and soybeans. Three factors were major contributors to wildlife use of fields: food availability, vegetation structure, and disturbance. Under most circumstances, availability of insects probably did not limit wildlife populations in agricultural fields. Preferred foods may be readily available in corn and soybean fields, but lack of adequate cover or vegetation characteristics may prevent some species from utilizing resources present.

Center for Resource Economics. 1992. Farm Bill 1990 revisited. Center for Resource Economics, Washington, D.C. 44 pp.

Cihacek, L. J. 1993. Selection criteria for retention of CRP land in permanent cover. Pages 41-88 *in* Proceedings of the Great Plains Agricultural Council. Annual meeting, June 2-4, 1993, Rapid City, South Dakota.

Clark, R. G., and T. D. Nudds. 1991. Habitat patch size and duck nesting success: The crucial experiments have not been performed. Wildlife Society Bulletin 19: 534-543.

Authors argued that there was conflicting evidence concerning relationship between patch size and nest success of upland nesting birds. Whereas some studies showed that nest success increased with greater area and lower density of nests, others indicated that there was no positive relationship between area and success. They argue that more information about relationship between patch size and composition of managed habitats and duck nesting success is needed. Key questions include: (1) What kind of cover needs to be planted and how much? (2) Are ducks doing better in managed patches than in unmanaged patches? (3) What is the standard of comparison (e.g, nest success, duckling survival)? (4) Are program costs effective? Their review of literature did not clearly support or refute the hypothesis that duck nesting success should be greater in larger patches. Authors criticized the rational of establishing relatively small (< 300 ha) areas of cover and suggested that effort and limited funds be redirected to changing agricultural policy and programs.

Clark, W. R., and T. R. Bogenschutz. 2000. Grassland habitat and reproductive success of ring-necked pheasants in northern Iowa. Journal of Field Ornithology 70:380-392.

Incubation initiation date, clutch size, and nest and hen success of pheasants compared between Iowa study sites having high habitat diversity with 25% grassland and low habitat diversity with 9.3% grassland. There were no differences between study sites in initiation dates of first nests or clutch size; initiation date of second nests was earlier and hen and nest success were greater in high diversity than in low diversity area. Nest success was negatively related to patch size.

Clark, W. R., R. A. Schmitz, and T. R. Bogenschutz. 1999. Site selection and nest success of ring-necked pheasants as a function of location in Iowa landscapes. Journal of Wildlife Management 63:976-989.

Study of site selection and nest success of ring-necked pheasants as a function of location in Iowa landscapes. Success was highest in fields ≥ 160 acres. Cover in several large blocks was better than one large block. Both probability of nest-site selection and nesting success were influenced by configuration of habitat within one home range radius of nest site. Specific vegetation type at nest location was not predictive of selection or success. Authors suggested that biologists must understand how landscape configuration is influenced by agricultural policy if managers are ultimately to influence wildlife populations. They recommended that managers strive to provide undisturbed grassland in blocks of ≥ 15 ha (40 acres) for nesting pheasants.

Cline, G. A. 1988. Habitat relationships of bobwhite quail and cottontail rabbits on agricultural lands in Halifax County, Virginia. M.S. thesis. Virginia Polytechnic Institute and State University, Blacksburg. 99 pp.

Author evaluated Habitat Suitability Index (HSI) models for bobwhite quail and cottontail rabbits on agricultural lands in Halifax County, Virginia. Wooded fallow fields, length of pasture/fallow, forest/forest edge, and total number of all edges present were positively related to quail presence. Author recommended that the number of different edges and number of fallow fields in early successional stages be maximized. Cultivation of field borders, corners, waterways, and other idle areas should be discouraged. He suggested that a large number of small fields, each with a fallow or brushy border, was better than same acreage encompassed in only a few fields. Author concluded that models correctly predicted habitat preferences of bobwhites.

Cochrane, W. W. 1993. The development of American agriculture: A historical analysis. University of Minnesota Press, Minneapolis. 500 pp.

A thorough and arresting review of agricultural development in the United States from the early colonial period to 1990. Author described changes in agriculture in relation to settlement, industrialization, technological development, and expansion to world markets. The book furnished a historical perspective on current agricultural policies and their implications for environmental policy and continuing development of the agricultural sector.

Conover, M. 1998. Perceptions of American agricultural producers about wildlife on their farms and ranches. Wildlife Society Bulletin 26:597-604.

Survey of attitudes of American agricultural producers about wildlife on their farms and ranches. Agricultural producers control 45% of U.S. surface area representing enormous potential impact on wildlife resources. Survey indicated that agricultural producers generally placed high value on wildlife and annually spent millions of dollars trying to enhance wildlife populations on farms and ranches. Improvement activities included providing cover or water and leaving a portion of crop or residue for wildlife use. Conversely, crop damage by wildlife can be expensive and severe and may limit participation by agricultural producers in wildlife enhancement efforts.

Cook, K. A. 1994. So long, CRP. Environmental Working Group/The Tides Foundation Report. Washington, D.C. 38 pp.

Cook, K. A., and A. B. Art. 1993. Countdown to compliance: implementation of the resource conservation requirements of federal farm law. Center for Resource Economics. Washington, D.C. 37 pp.

Council for Agricultural Science and Technology. 1990. Ecological impacts of federal Conservation and Cropland Reduction Programs. Task Force Report No. 117. Ames, Iowa. 28 pp.

Overproduction in agriculture first became a major problem following WWI. High demand for food and fiber during the war quickly disappeared after the war. This pattern was repeated following WWII. World demand was a major factor influencing domestic production and prices. Technological advancements and increased productivity per acre also contributed to overproduction. Between 1930 and 1980, farm production rose by almost 150%. If CRP reaches its goal of 45 million acres, it is estimated that soil erosion will be reduced by 850 million tons/yr. Other CRP benefits include improved ground surface water quality, reduced nitrate and pesticide use, and decrease in commodity surpluses. Task force recommendations included: (1) extend period that a field may be idled from one to three to five years; (2) ban fallowing of idle land without cover; (3) require ASCS to consider wildlife when setting rules for seeding and destruction of cover; and (4) include natural resource professionals on ASCS committees.

Council for Agricultural Science and Technology. 1995. The Conservation Reserve: A survey of research and interest groups. Special Publication 19. Ames, Iowa. 44 pp.

Cowardin, L. M., D. S. Gilmer, and C. W. Shaiffer. 1985. Mallards and agricultural programs. Transactions of the North American Wildlife and Natural Resources Conference 49:132-140.

Declining quality of wildlife habitat has not been considered a high priority problem by ASCS committees charged with allocating Agricultural Conservation Program dollars. Prior to the 1985 Farm Bill, biologists from 12 of 14 midwestern states documented declines in wildlife populations related to changing land uses and agricultural practices. Specifically, analysis revealed a 91% decrease in pheasants, 72% decline in cottontails, and 83% decline in bobwhites. Population declines were attributed to conversion of quality nesting cover, small grains, pasture, and other nonfarmed cover types to rowcrops. Factors also identified as contributing to reduced habitat quality were loss of edge, old farmsteads, wetlands and idle areas; increased farm and field size; and a major shift from diversified farms to simplistic agricultural landscapes. Authors summarized weak points of agricultural programs (e.g., Payment in Kind) and offered basic wildlife recommendations for 1985 Farm Bill.

Cowardin, L. M., A. B. Sargent, and H. F. Duebbert. 1983. Low waterfowl recruitment in the prairies: The problem, the reasons, and the challenge to management (abstract only). Pages 16-18 *in* H. Boyd, editor. First Western Hemisphere Waterfowl and Waterbird Symposium. International Waterfowl Research Bureau, Slimbridge, England.

Estimates of waterfowl nest success in the northern United States were in the range of 5-15%, except in western North Dakota where success rates of 38% and 42% were reported. Authors indicated that differences in success reflected variation in habitat quality and predator populations. Lowest success rates were observed in areas with intensive agriculture. Authors tied low waterfowl recruitment to destruction of habitat and increased predation rates in remaining suitable habitat. They argued that intensive agriculture had decreased both the availability of nesting cover and habitat available to resident prey species. As a result, nesting ducks and foraging predators were concentrated in remaining untilled grassland. They proposed that a key management strategy should be to separate nest predators from nesting waterfowl. The authors concluded that habitat preservation is essential but also requires purposeful management of predators.

Cowardin, L. M., T. L. Shaffer, and K. M. Kraft. 1995. How much habitat management is needed to meet mallard production objectives? Wildlife Society Bulletin 23:48-55.

Application of cost-benefit analysis of management required to increase mallard recruitment in Prairie Pothole Region. Simulations provided guidance for managers seeking to optimize allocation of limited resources for mallard recruitment.

Cully, J. F., and H. L. Michaels. 2000. Henslow's sparrow habitat associations on Kansas tallgrass prairie. Wilson Bulletin 112:115-123.

Examination of macro- and microhabitat characteristics of Henslow's sparrows breeding on Kansas military reservation, 1995-1996. Sparrows associated with grassland two to three years after burning. Compared to random survey points, use sites had lower tree density, but similar shrub density and military disturbance. Use sites characterized by tall, dense, structurally homogeneous vegetation with high litter cover.

Curtis, J., T. Profeta, and L. Mott. 1993. After silent spring: the unsolved problems of pesticide use in the United States. Natural Resources Defense Council. New York. 56 pp.

In 1991, 2.2 billion pounds of pesticides, or 8 pounds for every man, woman, and child in the country, were applied in the United States. Seventy-one active ingredients in pesticides that have been found to cause cancer in animals or humans were used on food crops. EPA estimated that 10% of public wells and 440,000 rural private water wells contained pesticides. At a minimum, 1.3 million people were drinking water contaminated with one or more pesticides.

Agriculture generally is considered the largest source of surface water pollution in the United States and pesticides are one of the principal contaminants. A recent USGS study of the Mississippi River Basin detected carcinogenic herbicide atrazine in 100% of samples; levels exceeded the federal drinking water standard in 27% of samples. Atrazine levels were three-times the legal limit in Platte River samples. Herbicides were used on 95% of corn and soybean farms. In 1991, the amount of active ingredients applied to farmland was 2.7 lb/acre. There are 25,000 chemical products on the market today containing approximately 750 active ingredients.

Groundwater is the primary source of drinking water for 97% of rural residents and > 50% of total U.S. population. EPA (1988) documented 74 different pesticides in groundwater samples from 32 states. Since 1962, number of pesticide-resistant insects and mites has risen from 137 to 447. Additionally, over 100 species of plant pathogens and 48 species of weeds have developed pesticide resistance. Pesticide use can be reduced from 25 to 80% on nine major U.S. crops by using practices such as integrated pest management, biological control, crop rotations, cover crops, and ridge-tillage.

In 1990, 38% of U.S. food samples contained pesticides. This estimate was considered conservative because the five most commonly used laboratory tests were able to detect only half of pesticides used on foods. At least 300 different pesticides are used on food, 71 of which are known carcinogens. Other pesticides are neurotoxic and reproductively toxic, causing premature birth and low birth weight. Conventional laboratory methods can only detect 203 of 426 pesticides FDA has identified as likely to leave residues in food. Children are getting larger doses of pesticides because their food intake is larger percentage of body weight. For example, the average toddler drinks 31-times more apple juice as percentage of body weight than the mother.

Recent (1992) NOAA report documented fish kills, and decreased mean density and diversity of species due to runoff of 35 commonly used agricultural pesticides into coastal waters.

Cutler, M. R. 1991. Meeting the biodiversity challenge through coordinated land use planning. Renewable Resources Journal 9:13-16.

Dahlberg, K. A. 1992. The conservation of biological diversity and U.S. agriculture: Goals, institutions, and policies. Agriculture, Ecosystems and Environment 42:177-193.

Agriculture's transformation over the past several decades has led to an increasing genetic depletion in farm habitats and rural landscapes. Ways to modify policy to enhance diversity in agricultural landscapes include making changes in current set-aside policies, credit programs, and rangeland management. Water and energy should receive priority, but aesthetic value and diversity of rural landscapes should also be considered. Author suggested that the goal should be to achieve a more diversified lower-input agricultural system.

American agriculture has gone from small scale, diversified production, local marketing systems dependent largely upon human and animal labor to large-scale monocultures dependent on cheap energy and large markets. Size of rural populations and the number of farmers in U.S. population have declined. Pressures to expand production have led to greater simplification of the agricultural ecosystem and elimination of habitat for wildlife and pest predators, and increased soil erosion and groundwater pollution.

An important part of seeking new policy direction will be to educate the public regarding the value and importance of rebuilding a strong, diverse rural America. Author recommended changes in current set-aside policies designed to reduce overproduction. Farmers in grain-growing areas should be encouraged to leave unharvested portions of fields as cover.

Danielson, B. J. 1992. Habitat selection, interspecific interactions and landscape composition. Evolutionary Ecology 6:399-411.

Author described three types of habitats: (1) sources—reproduction exceeds mortality; (2) sinks—reproduction limited, inadequate to compensate for mortality; (3) unusable habitats—comprises the matrix of all habitats that are never exploited by the species. Patches of source and sink habitat are embedded in usable habitat. Preserving population and community characteristics that have evolved under natural conditions by restoring landscapes to natural state is rarely possible. May be able to compensate for fragmentation where unusable habitats have been increased by clustering patches of usable habitat and connecting the patches with dispersal corridors. Author emphasized that spatial scale of conservation efforts must be defined by the ecology of the species in question.

Davis, C. A., T. Z. Riley, R. A. Smith, H. R. Suminski, and M. D. Wisdom. 1979. Habitat evaluation of lesser prairie chickens in eastern Chaves County, New Mexico. Department of Fisheries and Wildlife Sciences, New Mexico Agricultural Experiment Station. 141 pp.

Recommended 64 ha exclosures to ensure sufficient winter cover and nesting habitat for lesser prairie chickens in eastern Chaves County, New Mexico.

Davis, M. A., D. W. Peterson, P. B. Reich, M. Crozier, T. Query, E. Mitchell, J. Huntington, and P. Bazakas. 2000. Restoring savanna using fire: Impact on breeding bird community. Restoration Ecology 8:30-40.

Analysis of the effects of fire on oak savanna avian community. Insectivorous birds that feed in upper canopy declined, while omnivorous ground feeders and insectivorous bark gleaners increased during restoration. Overall, savanna restoration resulted in increases in abundance of open country birds, including many declining bird species of special conservation concern.

Davidson, J. H. 1995. Conservation agriculture: An old new idea. Natural Resources and Environment 9:20-22.

Response to agricultural impacts to environmental quality by lawmakers has been cautious and exploratory. They have shown a clear reluctance to impose regulatory constraints on producers. Environmental Conservation Acreage Reserve Program (ECARP) consisting of CRP and WRP was created to assist owners and operators of highly erodible land, fragile lands, and wetlands in improving soil and water quality. Continued high levels of erosion and water contamination strongly suggest that conservation measures are not being universally applied or continued. The author indicated that the primary reason for continued erosion is USDA shift from soil-conserving practices to production enhancement. The amount of voluntary compliance by private landowners roughly parallels the amount of federal cost-sharing dollars available. Federal programs that rely on voluntary adoption of conservation practices have not worked well in the past. The author concluded that environmental quality goals would only be reached with subsidies or regulation.

Delisle, J. M., and J. A. Savidge. 1997. Avian use and vegetation characteristics of Conservation Reserve Program fields. Journal of Wildlife Management 61: 318-325.

Comparison of avian use of CP1 (cool-season grasses and legumes) and CP2 (warm-season, native grasses in southeastern Nebraska. Total bird abundance did not differ between CP1 and CP2. In winter and breeding season, CP2 had taller denser vegetation than CP1 fields. Bobolinks and meadowlarks were more abundant in CP1. Sedge wrens preferred fields with structurally complex vegetation but disappeared after these fields had been mowed or burned. Common yellowthroats were associated with tall vegetation and were more abundant in CP2. Grasshopper sparrows disappeared from fields as litter depth increased and dead vegetation accumulated. CP2 fields that were mowed three out of four years maintained consistent grasshopper sparrow numbers. CP2 was preferred by pheasants for winter cover. Authors concluded that native plantings alone could provide habitat for all native birds if some fields were managed more intensively to simulate historical disturbances. CP1 provided the best habitat for species that nested directly on ground and preferred low vegetation height and litter depth. CP2 was used by species that nested higher in vegetation and preferred dense growth.

Dicks, M. R. 1994. Costs and benefits of CRP. Pages 39-44 *in* When Conservation Reserve Program contracts expire: The policy options. Soil and Water Conservation Society, Ankeny, Iowa.

This article reported that the CRP has provided numerous benefits. However, the author was unable to estimate net gains or losses to society due to CRP at the end of the first 10-year contract period. He stated that is imperative to determine the social response to landowners' post-CRP intentions. The author concluded that this type of information is vital to determine if the $19 billion spent at the time of this study was cost effective and if any future expenditures have measurable benefits to society.

Dicks, M. R., and J. E. Coombs. 1995. CRP in the future. Great Plains Agricultural Policy Center. Oklahoma Agricultural Experiment Station, Oklahoma State University, Stillwater.

Dicks, M. R., L. D. Sanders, and S. Anderson. 1990. Agricultural ecopolitics: Conflicts of agricultural policies with resource conservation and sustainable agriculture. Pages 89-98 *in* P. J. Hoefer, G. H. Fechner, and S. E. McDonald, technical coordinators. Trees are the answer: Great Plains Agricultural Council, Forestry Committee, Publication No. 132.

Central theme of federal agricultural policy is controlling the variability in agricultural production and commodity prices. During first 150 years of American history, federal policy successfully promoted the expansion of U.S. farmland. Past agricultural policy may have influenced resource use. Current policy is shifting focus to supply management, placing restrictions on resource use rather than just land use. The greatest need for education and research rests with integrating conservation practices with cropping systems.

The 1980s were a transitional decade for agricultural policy with focus shifting from production control to production management. The environmental impacts of alternative agricultural production control policies were considered during the development and implementation of legislation. Since the 1930s, agricultural policies have sought to modify farmers' allocation of resources almost exclusively through use of positive and negative incentives.

Peak of U.S. farmland acreage was over 1.2 billion acres in the 1950s. Farmland acreage devoted to cropland peaked at nearly 395 million acres in early 1950s. Total production of the basic commodities has grown rapidly since the 1950s as technology brought improvements in productivity. Federal policies designed to boost agricultural output through research and extension continue to achieve this goal.

Diebel, P. L., T. T. Cable, and P. S. Cook. 1993. The future of Conservation Reserve Program land in Kansas: The landowner's view. Kansas Agricultural Experiment Station, Kansas State University, No. 94-45-S. 56 pp.

The majority of survey respondents were satisfied with CRP and ranked soil erosion as an important influence in initial enrollment. Wildlife habitat considerations affected decisions of 67.7% of respondents. However, 57.6% said increases in wildlife populations were undesirable. Hunting was most frequent form of recreation allowed on CRP land (76.4%). Market prices, forage, and livestock were key factors in decision about future use of CRP land.

Dillaha, T. A. III, J. H. Sherrard, and D. Lee. 1989. Long-term effectiveness of vegetative filter strips. Water, Environment and Technology 1:418-421.

Summary of filter strip effectiveness. Taller weeds shaded desirable grasses and reduced effectiveness. Mowing, herbicides, and reseeding or combinations of the three could improve effectiveness. Cattle decreased quality and effectiveness of filter strips.

Dijak, W. D., and F. R. Thompson III. 2000. Landscape and edge effects on the distribution of mammalian predators in Missouri. Journal of Wildlife Management 64:209-216.

Relative abundance of forest songbird nest predators (raccoons, opossums, and striped skunks) was examined at local and landscape scales to determine predation risks in Missouri. Raccoon abundance was related to latitude, stream density, and mean patch size of agricultural lands. Opossum abundance was related to stream density, contagion, mean nearest neighbor distance between forest patches, and latitude. Skunk abundance was not related to landscape characteristics examined. Raccoons were more abundant along edges than in forest interior. No pattern was observed for opossums. Author concluded that local and landscape patterns affected predator abundance and songbird nest predation rates.

Doak, D. F., P. C. Marino, and P. M. Kareiva. 1992. Spatial scale mediates the influence of habitat fragmentation on dispersal success: Implications for conservation. Theoretical Population Biology 41:315-336.

Heterogeneity has different and conflicting effects on animal movement at different scales. Explicit consideration of scale is essential in discussion of habitat fragmentation and optimal conservation strategy. Major impact of fragmentation is disruption of animal dispersal at two scales: the relative size of the habitat fragments and the spatial scale at which these fragments are arranged. When fragmentation is unavoidable, dispersal mortality may be minimized by clustering habitat fragments. Clustering seems to have a positive influence on dispersal success, but authors cautioned that the appropriate spatial scale of clustering must be defined. Scale affects risks of mortality, degrees of connectivity, or independence among patches and the influence of environmental catastrophes.

Doering, O. 1992. Federal policies and incentives or disincentives to ecologically sustainable agricultural systems. Pages 21-36 *in* R. K. Olson, editor. Integrating sustainable agricultural, ecology and environmental policy. Haworth Press, New York.

Sustainable agriculture involves less use of off-farm inputs while introducing new management and cropping systems that better utilize on-farm resources. Until recently, federal farm policies have not been concerned with environmental issues but rather reflected goals of increased farm income and low cost food for the nation. Other goals, such as improving rural conditions, increasing rural income, improving farming operations, and conserving natural resources, have formed foundation of agricultural policy in recent decades. At times, these policies have conflicted in their goals and outcomes. Future policies must be more highly focused on addressing environmental impact of agriculture if continued support of nonagricultural sector is to be expected. Paper provided useful statistics on changes in quantities of off-farm inputs required

for production in recent decades. Since World War II, use of fertilizers and pesticides has increased because they have become cheap compared to labor, fuel, and machinery. The CRP has reduced environmental problems, but the program does not address environmental concerns relative to those acres remaining in production and the long-term use of CRP acres. There needs to be a stronger emphasis in agricultural policy that considers long-term environmental quality.

Duebbert, H. F. 1969. High density and hatching success of ducks on South Dakota CAP lands. Transactions of the North American Wildlife and Natural Resources Conference 34:218-228.

Duebbert, H. F., and J. T. Lokemoen. 1976. Duck nesting in fields of undisturbed grass-legume cover. Journal of Wildlife Management 40:729-740.

Study estimated nest density, hatching rates, egg hatchability, and annual duckling production for mallards, blue-winged teals, and gadwalls nesting in Cropland Adjustment Program fields in north-central South Dakota, 1971-1973. Nesting cover consisted of introduced cool-season grasses and legumes, primarily smooth bromegrass, intermediate wheatgrass, and alfalfa.

Dumont, P. G. 1991. Grasslands, wetlands and more wildlife. Soil and Water Conservation News 12:6-10.

This article described the CRP sites and landowner attitudes in North and South Dakota. The developing partnership between the U.S. Fish and Wildlife Service and Soil Conservation Service was discussed. The Water Bank Program was briefly mentioned. Photographs illustrated the dramatic responses of wildlife to CRP grasslands and restored wetlands.

Dunn, C. P., F. Stearns, G. R. Guntenspergen, and D. M. Sharpe. 1993. Ecological benefits of the Conservation Reserve Program. Conservation Biology 7:132-139.

Unintentional, yet significant, ecological benefits of CRP: reversal of landscape fragmentation, maintenance of regional biodiversity, development of wildlife habitat, and regional changes in carbon flux. Dollar benefits derived from program are difficult to precisely quantify. Nonetheless, authors suggested that overall program costs would be more than offset by benefits from increased net farm income, soil productivity improvements, enhanced water quality, and revenue from recreational activities. These and other benefits should be used by policy makers to justify continuation of the program.

Edwards, W. R. 1984. Early ACP and pheasant boom and bust! - a historical perspective with rationale. Pages 71-83 *in* R. T. Dumke, R. B. Sthiel, and R. B. Kahl, editors. Proceedings: Perdix III. Gray partridge and ring-necked pheasant workshop. Wisconsin Department of Natural Resources, Madison.

Ekstrand, E. 1993. Wildlife economics of the CRP. Pages 52-54 *in* C. Lee, editor. Will there be a lasting conservation legacy? Proceedings of Midcontinent CRP Conference, Kansas Wildlife and Parks, Manhattan.

Ekstrand, E., and R. L. Johnson. 1994. Application of farm programs to water quality. Pages 541-544 *in* D. G. Fontane and H. N. Tuvel, editors. Water policy and management: Solving the problems. Proceedings of the 21st Annual Conference of the Water Resources Planning and Management Division. American Society of Civil Engineers, New York.

Ervin, D. E. 1986. Constraints to practicing soil conservation: Land tenure relationships. Pages 95-107 *in* S. B. Lovejoy and T. L. Napier. Conserving soil: Insights from socioeconomic research. Soil and Water Conservation Society, Ankeny, Iowa.

Farmland tenancy in the United States underwent several major changes in the 1970s: percentage of total farmland owned by nonoperator landlords rose, use of fixed-cash rental contracts increased, and landlords contributed a lesser share of total farm production and capital expenditure. These events imply increased separation of ownership from management of farmland. Tenants will only be willing to invest in soil erosion control if the productivity benefits or input cost savings outweigh costs of erosion control during rental period. Landlords may under-invest in soil erosion control because benefits will be captured by tenants who do not share in the costs. Unless tenant operators expect to rent land for an extended period of time or intend to purchase the land, a program oriented to renter will miss the long-term incentives that owners have. Attempts to persuade landowners and tenants that conservation is a good thing without sound data may succeed in short run but approach will ultimately fail when the real benefits and costs are realized. In the mid-1980s, 40% of U.S. farmland was leased.

Ervin, D. E. 1991. Conservation and environmental issues in agriculture. U.S. Economic Research Service, Resources and Technology Division. Washington, D.C. 62 pp.

Evard, J. O., D. A. Snobl, P. B. Doeneir, and J. A. Dechant. 1991. Nesting of short-eared owls and voles in St. Croix County. The Passenger Pigeon 53:223-226.

Increased numbers of predators, such as short-eared owls, red foxes, coyote, and rough-legged hawks, were attributed to high concentration of meadow voles in CRP lands. Two short-eared owl nests were found in CRP. This species has rarely been recorded nesting in Wisconsin. Presence of nests attributed to CRP habitat supporting high density of meadow voles.

Faeth, P., R. Repetto, K. Kroll, Q. Dai, and G. Helmers. 1991. Paying the Farm Bill: U.S. agricultural policy and the transition to sustainable agriculture. World Resources Institute. Washington, D.C. 70 pp.

Farmer, A. H., R. L. Hays, and R. P. Webb. 1988. Effects of the Conservation Reserve Program on wildlife habitat: A cooperative study. Transactions of the North American Wildlife and Natural Resources Conference 53:232-238.

Description of plant and animal monitoring efforts of CRP lands in the Midwest and northern Great Plains initiated in 1987.

Farris, A. L., and S. H. Cole. 1981. Strategies and goals for wildlife habitat restoration on agricultural lands. Transactions of the North American Wildlife and Natural Resources Conference 46:130-136.

Indicators of decline in farmland wildlife habitat are increased urbanization of agricultural land; increased size of farms, field size, and acres in rowcrops; decreased area in production of small grains, wild/tame hay, and pasture; and loss of edge, fencerows, farmsteads, wetland and idle lands. All have contributed to reductions in numbers and diversity of wildlife. Agricultural policy is the primary influence on agricultural land use and farmland wildlife habitat.

Native grasses, while taking more care and time to establish, provide excellent erosion control with significantly lower cost and energy utilization. Long-term benefits of native grasses versus nonnative cool-season grasses are significant. Cutting for hay should be delayed until after July 15. Authors endorsed cost-sharing for farmers that devote a minimum percentage of cropped acreage to permanent cover capable of supporting wildlife. They suggested that 4-5% of landscape probably was sufficient.

Farris, A. L., and R. M. Gray. 1989. Effects of the Conservation Reserve Program on wildlife habitat: Results of 1988 monitoring. Transactions of the North American Wildlife and Natural Resources Conference 54:365-376.

Report on vegetative characteristics and pheasant, meadowlark, and eastern cottontail Habitat Suitability Index (HSI) values for CRP lands in Midwest in 1987-1988. Conclusions: (1) Composition of early successional fields dominated by weedy species with persistence of vegetation varying among conservation practices (greatest in CP2); (2) HSI values calculated for early successional fields suggested fair-good nesting habitat for pheasants and meadowlarks, but no improvement for cottontails; (3) introduction of woody plants and persistent herbaceous vegetation and food plots recommended to overcome limitations in winter food and shelter for pheasants; and (4) mowing and haying of CRP fields adversely impacted nesting birds.

Fauth, P. T. 2000. Reproductive success of wood thrushes in forest fragments in northern Indiana. Auk 117:194-204.

Analysis of brown cowbird brood parasitism, nest density, nest predation, and reproductive success of wood thrush nests in forest fragments in northern Indiana. Thrush density was negatively related to fragment size. Parasitism of thrush nests was 90%. Number of parasitic eggs/nest was unrelated to fragment size, host abundance, or distance to edge, but positively related to thrush abundance. Nest predation was unrelated to fragment size or distance to edge. Author concluded that thrushes had low fecundity in agriculturally dominated northern Indiana and recommended that conservation efforts be directed at preserving and enhancing habitats in regions where parasitism and predation are reduced.

Fawcett, R. S. 1982. Weed control strategies under different tillage regimes. Page 12 *in* R. B. Dahlgren, compiler. Midwest agricultural interfaces with fish and wildlife resources workshop. Iowa State University, Iowa Fish and Wildlife Cooperative Research Unit, Ames.

Use of selective herbicides resulted in improved weed control, reduced tillage, and increased crop yields. Herbicides apparently have little direct effect on wildlife, but use associated with losses of habitat and forage. About 97% of all corn and soybeans in Iowa were treated with herbicides.

Feather, P., D. Hellerstien, and L. Hansen. 1999. Economic valuation of environmental benefits and the targeting of conservation programs: The case of the CRP. U.S. Department of Agriculture, Economic Research Service. Agricultural Economic Report Number 778. 56 pp.

Report demonstrated how nonmarket valuation models could be used to refine enrollment into conservation programs such as CRP. Environmental targeting was defined as directing resources to lands where the greatest environmental benefit was generated for a given expenditure (i.e., least cost). Report examined use of nonmarket valuation models for freshwater-based recreation, wildlife viewing, and pheasant hunting, and potential changes in distribution of land enrolled in CRP. If public preferences are explicitly known, then such valuation based targeting of CRP might improve performance and benefits of program. Analysis showed that substantial shifts in geographic location of lands enrolled in program may occur depending on what criteria and priorities are used for targeting.

Frawley, B. J. 1989. The dynamics of nongame bird breeding ecology in Iowa alfalfa fields. M.S. thesis. Iowa State University, Ames. 94 pp.

Eight nongame bird species (dickcissel, red-winged blackbird, western meadowlark, common yellowthroat, sedge wren, grasshopper sparrow, and vesper sparrow) established territories in alfalfa fields before mowing. Mowing reduced their numbers and density. Only dickcissels, grasshopper sparrows, western meadowlarks, and vesper sparrows attempted to nest in second growth alfalfa fields. Common yellowthroats selected the tallest, densest vegetation with relatively high coverage of grass; grasshopper sparrows used areas of sparse vegetation. Western meadowlark abundance seemed unrelated to vegetation changes.

Needs of ground nesting birds are difficult to integrate with forage management practices. In Iowa, highest yields and forage quality are obtained by harvesting alfalfa in early June. Fields typically are harvested two more times at five- to six-week intervals. Forage production on private lands will continue to intensify with greater production, new cultivars, and earlier mowing. For example, new species of cultivars will permit earlier mowing while maintaining high yields. CRP may provide some compensation for losses of habitat in alfalfa, but mowing of CRP during the nesting season would negate its potential benefit.

Freemark, K. 1988. Agricultural disturbance, wildlife and landscape management. Pages 77-84 *in* M. R. Moss editor. Landscape ecology and management. Canadian Society for Landscape Ecology and Management Symposium, University of Guelph, Ontario, Canada.

Investigation of bird species richness and reproduction in forested habitats impacted by agricultural production. Wildlife in agricultural landscapes are subject to a number of disturbances, such as habitat fragmentation and pesticide use, which have impact on their spatial and temporal distribution. Understanding relationships between landscape structure, disturbance and distribution of wildlife is needed to develop better management strategies to minimize potential impact and to enhance the persistence of wildlife community.

Freemark, K. 1995. Assessing effects of agriculture on terrestrial wildlife: Developing a hierarchical approach for the U.S. EPA. Landscape and Urban Planning 31: 99-115.

Given the intensive and extensive extent of agriculture, there is a need to develop the conceptual and scientific basis for landscape design and management to promote sustainable agricultural practices that enhance conservation and environmental priorities associated with agricultural ecosystems. Retrospective analysis may provide insights into the range of possibilities for future landscape design and management scenarios in a given area. Major limitation of many previous studies of wildlife on farmland has been the focus on detailed studies of small plots with little regard to larger spatial scales.

Freemark, K., and C. Boutin. 1995. Impacts of agricultural herbicide use on terrestrial wildlife in temperate landscapes: A review with special reference to North America. Agricultural Ecosystems and Environment 52:67-91.

Review of the effects of agricultural herbicides on terrestrial wildlife in North America and Europe. Strong evidence cited for adverse effects of chemicals on habitats in temperate landscapes of North America, beneficial insects and arthropods in Europe, and birds in North America and Europe. Authors recommended additional research to develop toxicity testing guidelines for nontarget plants, identify ecologically relevant plant species for laboratory tests, multi-species field tests, improved methods of risk assessment, and mitigation options.

Freemark, K. E., J. R. Probst, J. B. Dunning, and S. J. Heji. 1993. Adding a landscape ecology perspective to conservation and management planning. Pages 346-352 *in* D. M. Finch and P. W. Stangle, editors. Status and management of Neotropical migratory birds. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-229. 422 pp.

Populations within individual habitat patches can decline, become extinct, and become reestablished by dispersal of individuals from other patches. The set of local populations that interact through dispersal is a metapopulation. Within a landscape, the probability of local extinction within a habitat patch is inversely related to size of the patch population which is proportional to the size and

habitat quality within the patch. Probability of recolonization is proportional to proximity and connectedness to similar habitat patches and permeability of the intervening matrix. Effective conservation of Neotropical migrant landbirds may require preservation of suitable but intermittently unoccupied habitat. Management plans should protect the diversity of habitats and landscapes used, not just where the species is most common.

Fry, G. L. A. 1991. Conservation in agricultural ecosystems. Pages 415-443 *in* I. F. Spellerberg, F. B. Goldsmith, and M. G. Morris, editors. The scientific management of temperate communities for conservation. Blackwell Scientific Publications, Oxford. Great Britain.

Protected areas alone cannot achieve conservation goals such as maintenance of biological diversity. Incorporation of conservation measures in farm management will demand clear recommendations based on sound theory and evidence gained through practical trials. Maintenance or enhancement of habitat quality for a wider range of plants and animals will require better understanding of ecological processes at the site, field, and landscape levels. The design and management of habitats are constrained by the lack of understanding of the processes involved in animal distribution, the way in which species use corridors, and what constitutes barriers. Connectivity in a landscape that links isolated subpopulations to form metapopulations is one buffer against local extinction processes caused by habitat fragmentation.

Failure to consider effects of the next field or surrounding landscape is an important shortcoming of many investigations of wildlife in agricultural settings. The abundance of many species comprising animal communities on farmlands are controlled largely by a few environmental factors. Both the timing and severity of agricultural practices are important factors governing the potential of agricultural lands for wildlife. Extending the width of field margins farther into the field is one way of increasing habitat diversity on farmlands. Author concluded that management decisions often will need to be made without thorough assessment of the impacts on wildlife.

Furrow, L. T., K. F. Millenbah, R. B. Minnis, A. J. Pearks, H. Campa III, and S. R. Winterstein. 1993. Conservation Reserve Program: Not just for the birds (abstract only). Proceedings of the Midwest Fish and Wildlife Conference 55:170.

Gall, G. A. E., and G. H. Orians. 1992. Agriculture and biological conservation. Agriculture, Ecosystems and Environment 42:1-8.

Agriculture is the dominant form of land management on all continents. Intensity of management and capital investment in agriculture dramatically increased following World War II. Before that time, agriculture was sufficiently inefficient that habitats were provided for many species of wildlife. Multiple uses of land decline as intensity of land management increases. When prices of agricultural commodities increase, there is a decrease in consideration for recreational and aesthetic uses and values. Authors suggested that intensive agriculture should be focused on lands where efficiency is greatest. Pressures on marginal agricultural land then could be reduced, making them available for conservation practices that contribute not only to onsite habitat improvement but also enhancement of downstream environmental quality.

Gard, N. W., M. J. Hooper, and R. S. Bennett. 1993. Effects of pesticides and contaminants on Neotropical birds. Pages 310-314 *in* D. M. Finch and P. W. Stangle, editors. Status and management of Neotropical migratory birds. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-229. 422 pp.

Paper provided summary of potential effects of chemicals on migratory birds. Problems or effects of chemical applications and pollution remain difficult to assess; consequently, more is unknown than is known. Author recommended standardization of monitoring programs and selection of specific species as indicators.

Gatti, R. 1991. Evaluation of switchgrass nest cover for pheasants and ducks. Wisconsin Department Natural Resources, Madison. Project W-141-R, Final Report Study No. 127. 51 pp.

Pheasant and duck nest success was not consistently related to field size, shape, distance to water, cover height density, plant diversity, or cover type. Nest success was lower for nests closest to cover edges. Duck nest density was negatively related to plant diversity and positively related to height density of residual cover. Pheasant use was higher in fields with lower diversity of plant species, greater structural diversity, more irregular in shape, and further from water. Author concluded that widespread establishment of switchgrass nest cover and management of existing duck nest cover as monotypic stands of switchgrass was not justified based on costs, bird use, or nest success. He recommended management for diversity of cover types.

George, R. R., A. L. Farris, C. C. Schwartz, D. D. Humburg, and J. C. Coffey. 1979. Native prairie grass pastures as nest cover for upland birds. Wildlife Society Bulletin 7:4-9.

Lands seeded to pure stands of native grasses (switchgrass, Indiangrass, and big bluestem) that were properly managed as warm- season livestock forage, provided suitable nest cover for ring-necked pheasants and other upland nesting birds. In contrast, alfalfa and orchard grass hayfields produced no successful nests due to early season haying. Switchgrass was good cover because it maintained leaves, resisted burial by snow, and provided good residual spring cover. Passerine densities were highest in big

bluestem. Mixture of switchgrass, Indiangrass, and big bluestem was recommended for warm-season livestock forage and wildlife nesting cover. Little bluestem provided the best nesting cover, but it produced less forage and was more difficult to establish than other native grasses. Tall native grasses should not be grazed below 8-10 in. Grasses should be left undisturbed as much as possible in order to provide maximum residual cover in spring. Prescribed burns every 4-5 years will remove excess litter and prevent woody invasion.

Gerard, P. 1995. Agricultural practices, farm policy, and the conservation of biological diversity. U.S. Department of the Interior, National Biological Service. Biological Science Report 4. 28 pp.

Long-term declines in wildlife populations attributed to cropland expansion, agricultural intensification, and national farm policies. Where, when, and how crops are produced is influenced by social, economic, technological, and political factors. Close relationship between agricultural policy, land use practices, and wildlife populations illustrated by changes in prairie and Great Plains agricultural landscape and decline of grassland birds since the 1950s. Ability of CRP to slow or reverse population declines is limited by conflicting conservation objectives, voluntary nature of federal agricultural programs, and habitat requirements of affected species. Author maintains that biological conservation should be explicit objective of agricultural conservation policy. Additionally, full potential of CRP will only be realized when USDA works in partnership with conservation groups and conservation is decoupled from policies seeking to control commodity prices.

Gill, M., and S. Daberkow. 1991. Crop sequences among 1990 major field crops and associated farm program participation. U.S. Department of Agriculture, Economic Research Service, Agricultural Resources - Situation and Outlook Report. 24 October 1991.

Gillespie, G. W., and F. H. Buttel. 1989. Understanding farm operator opposition to government regulation of agricultural chemicals and pharmaceuticals: The role of social class, objective interests, and ideology. American Journal of Alternative Agriculture 4:12-21.

Report summarized results of a survey of farmers conducted in New York in 1982. Farmer opposition to government regulation of agricultural chemicals was primarily due to farmer ideology and was unrelated to farmers' experiences with chemicals. Farmer activities were increasingly affected by forces external to agriculture, including increased role of manufactured inputs into agricultural production. Farmers tended to have conservative socio-political orientation. They primarily were concerned about health and safety rather than environmental quality. In general, farmers were strongly opposed to regulation. Opposition to government regulation was associated with farm size, proportion of income derived from farming, and level of concern about possible side effects of chemicals.

Gilpin, M., G. A. E. Gall, and D. S. Woodruff. 1992. Ecological dynamics and agricultural landscapes. Agriculture, Ecosystems and Environment 42:27-52.

Many parts of society see conflicts between conservation of biological resources and exploitation by agriculture. Agricultural production is essential to society. Agriculture also can provide stewardship for conservation of biological resources, but an interdisciplinary effort is needed for development of strategies that reward agriculture for good conservation. Agriculture and conservation are not mutually exclusive and can be positively linked on local, regional, and global scales. Governmental policies that support agriculture are often ineffective and underestimate true economic constraints.

Gliessman, S. R. 1984. An agroecological approach to sustainable agriculture. Pages 160-171 *in* W. Jackson, W. Berry, and B. Coleman, editors. Meeting the expectations of the land: Essays in sustainable agriculture and stewardship. North Point Press, San Francisco.

The strong ecological foundation upon which agriculture originally developed eroded as production systems became increasingly linked to economics. The author defined an agroecological approach as one that examines how agriculture can be more in balance with the natural environment and less dependent on costly inputs. Goal of this approach is to establish a framework or long-term sustainability of agricultural systems. Agricultural ecology is based on the premise that the short-term, mainly economic, focus of food production must be redirected toward long-term management systems based on cycles and interactions with natural systems.

Gould, J. 1991. Seasonal use of Conservation Reserve Program fields by white-tailed deer in eastern South Dakota. M.S. thesis. South Dakota State University, Brookings. 40 pp.

CRP lands were used by white-tailed deer in greater proportion to their availability during spring, summer, and fall. They selected CRP during active periods in the spring and summer and during bedding periods in summer and fall, but avoided CRP during fall active periods. CRP land provided important forage and cover in all seasons. Whereas maintenance mowing and weed control generally are detrimental to wildlife populations, CRP fields must have some type of disturbance every few years to maintain quality of habitat. Author recommended that maintenance of CRP fields occur every three to five years in late summer subsequent to nesting season. He concluded that management of CRP may not be optimal for wildlife, but it was superior to croplands that it replaced.

Granfors, D. A. 1992. The impact of the Conservation Reserve Program on eastern meadowlark production and validation of the eastern meadowlark Habitat Suitability Index model. M.S. thesis. Texas Tech University, Lubbock. 98 pp.

Eastern meadowlark productivity compared between CRP land and rangelands in Lyon County, Kansas. Nests in CRP fields had lower cowbird parasitism, larger clutch sizes, and higher hatch rates than nests in pastures. Cowbird parasitism appeared to be a major cause of lowered productivity of meadowlark nests. Eastern meadowlarks selected for less dense litter and more homogenous vegetation structure in both land use types. Nests in CRP fields had higher proportion of grass than was available in random sites. In CRP fields, residual cover was greater near nest sites than in sites not used for nesting.

Relationship between HSI values and eastern meadowlark densities was poor, because of high densities of meadowlarks in fields with high forb coverage. Relationships improved when HSI values and densities were averaged over the three years of the study. No discernible relationship between western meadowlark densities and the eastern meadowlark model were detected.

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

Comparison of microhabitat, nest-site selection and nest success on Kansas rangelands and CRP. Daily nest survival rates and numbers fledged per female did not differ significantly between land use types. Mowing CRP fields was source of nest failure and induced adults to abandon some fields. CRP had significantly higher values for depth and density of litter cover, taller herbaceous canopy, less herbaceous cover, and more standing dead cover than rangelands. CRP has increased the diversity of available nesting habitats. Meadowlarks selected sites with greater litter cover, higher proportion of grass, more uncompacted litter, and more structural homogeneity than on random plots. Delay of mowing and burning recommended to enhance and maintain habitat suitability in CRP fields.

Mowing caused undesirable buildup of litter and, depending on time of year, may cause abandonment of fields and direct failure of nests. Consequently, partial mowing or spot mowing of fields after 15 July was recommended over complete mowing of field. Disadvantage of grazing is increased probability of trampling and attracting cowbirds. Prescribed burning can reduce litter and increase the proportion and vigor of native grasses while decreasing percentage of cool-season grasses and forbs. Although burning may cause temporary early-season loss in habitat quality, spring burning on three- or four-year rotation was recommended to maintain vigor of grass cover and reduce litter.

Graul, W. D. 1980. Grassland management practices and bird communities. Pages 38-47 *in* Management of western forests and grasslands for nongame birds. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, General Technical Report INT-86.

Grasslands contain relatively few bird species. However, there are many subtypes of grasslands that occur in a mosaic, and different species are restricted to different subtypes. Consequently, a general habitat category can contain considerably more species. Grassland bird communities tend to be numerically dominated by one or two abundant, widespread species. Grassland types contain species with extremely restricted habitat characteristics. Authors suggested that grassland management should be directed at providing habitat requirements of avian species with the most restrictive needs and maintain enough suitable habitat to support substantial numbers of the species. They assumed that species with broader habitat requirements would find suitable habitat.

Greenwood, R. J., A. B. Sargeant, D. H. Johnson, L. M. Cowardin, and T. L. Shaffer. 1987. Mallard nest success and recruitment in prairie Canada. Transactions of the North American Wildlife and Natural Resources Conference 52:298-308.

Study examined temporal and spatial variation in mallard nest success in prairie Canada. It identified causes of nest failure, determined species composition and densities of nest predators and estimated study area and overall recruitment rates. Authors observed much temporal and geographic variation. They determined that large native pastures containing brush were best duck nesting habitat in prairie Canada and recommended its protection.

Greenwood, R. J., A. B. Sargeant, D. H. Johnson, L. M. Cowardin, and T. L. Shaffer. 1995. Factors associated with duck nest success in the Prairie Pothole Region of Canada. Wildlife Monograph 128.

Study estimated nest initiation dates, habitat preferences, nest success, and nest fates for mallards, gadwalls, blue-winged teals, northern shovelers, and northern pintails nesting in Prairie Pothole Region of Canada. Nest success rate was most strongly associated with mallard production. Nest success varied both geographically and annually. Predators destroyed 72% of mallard, gadwall, blue-winged teal, and northern shoveler nests, and 65% of northern pintail nests. Nest success declined 4% for each 10% increase in cropland acreage, suggesting unstable local populations when cropland acreage exceeded 56% of available habitat.

Greenwood, R. J., A. B. Sargeant, J. L. Piehl, D. A. Buhl, and B. A. Hanson. 1999. Foods and foraging of striped skunks during the avian nesting season. Wildlife Society Bulletin 27:823-832.

Study of skunk food habits in Prairie Pothole Region of North Dakota during 1976-1978. Plant foods were of minor importance in spring and summer. Animal foods, primarily birds (including eggs), small rodents, and insects, were acquired exclusively in grasslands; proportion of animal (and insect) material in diet similar, irrespective of sex, season, or year. Sex and seasonal differences were detected in vertebrate foods. Bird and mammal foods declined in importance when wetland conditions were poor.

Griffin, S. L. 1991. Pronghorn use of agricultural land in northwestern South Dakota. M.S. thesis. South Dakota State University, Brookings. 63 pp.

Five percent of pronghorn observations were in CRP grasslands representing just 4% of the study area. Use of CRP often highest in early summer and winter when potential conflicts with agricultural interests were greatest. Timing and disproportionate use of CRP grasslands by pronghorns was interpreted as evidence that CRP may furnish high-quality foraging areas and thereby reduce depredation on small grain and alfalfa croplands. Future research should focus on better definition of pronghorn preferences for different grassland plantings permitted in program.

Gulinck, H. 1986. Landscape ecological aspects of agroecosystems. Agriculture, Ecosystems and Environment 16:79-86.

Discussion of the relevance of ecological concepts, especially landscape ecology, to agriculture. Author suggested that concept of landscape ecology may provide useful framework for reconciling human and environmental relationships.

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

Abundance of small mammals and species diversity were compared between native shortgrass grasslands and CRP fields in southern High Plains of Texas. CRP grasslands simulated shortgrass prairies in species diversity but not in species composition. CRP grasslands consisted of introduced grasses, primarily lovegrass, that allowed CRP to accomplish soil erosion goals but did not create "native habitat" with respect to plant or animal species composition. Successional changes in vegetational structure occurred in CRP sites. First-year sites on average contained more bare ground and less cover than older sites. Second-year sites were dense and almost homogenous with lovegrass. Third-year sites contained dense lovegrass, but it occurred in clusters or bunches interspersed with open spaces. In the first three years after establishment, diversity of small mammals was similar in CRP grasslands and shortgrass prairie. Species composition may be highly dependent on specific physiognomic parameters that were not met in either agricultural sites or CRP grasslands. Authors indicated that mammalian species composition might be restored if grazing or fire disturbance were incorporated into long-term management of CRP grasslands.

Harmon, K. W. 1981. Future actions for management of private land wildlife. Pages 374-382 *in* R. T. Dumke, G. V. Burger, and J. R. March, editors. Wildlife management on private lands. Wisconsin Chapter of the Wildlife Society, Madison.

Harmon, K. W. 1987. History and economics of Farm Bill legislation and the impacts on wildlife management and policies. Pages 105-108 *in* J. E. Mitchell, editor. Impacts of the CRP in the Great Plains. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-158.

Wildlife and economic considerations of long- and short-term land retirement contracts were compared. Author concluded that long-term contracts were better for pheasants and provided greater recreational and economic return.

Harris, B. L. 1991. Landowner options when CRP ends. Pages 24-26 *in* L. A. Joyce, J. E. Mitchell, and M. D. Skold, editors. The Conservation Reserve - yesterday, today and tomorrow. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-203. 64 pp.

Paper outlined options available to landowners when their CRP contracts expired. Options included reenrollment in CRP, plowing grass to allow for rowcrop production, or maintenance of permanent grass cover for grazing or haying. Author anticipated that landowner decision would be strongly influenced by economics and that most of the expiring contracts would go back into crop production unless assistance was provided to encourage use as pasture. Author concluded that compensation was inadequate to prevent conversion back into cropland. He recommended that further development of CRP include incentives for farmers to retain grass cover on highly erodible lands.

Hays, R. L., and A. H. Farmer. 1990. Effects of the CRP on wildlife habitat: emergency haying in the Midwest and pine plantings in the Southeast. Transactions of the North American Wildlife and Natural Resources Conference 55:30-39.

The authors reported the preliminary results of 1988 sampling conducted in the Midwest region to determine the effects of the CRP on wildlife. The study objectives were to: (1) describe the conservation practices and vegetation of CRP fields; (2) describe trends in wildlife habitat resulting from CRP establishment; and (3) summarize the results for use in the development of the 1995 Farm Bill. Preliminary conclusions were that (1) vegetation establishment was progressing on CRP fields with weeds dominating; (2) CRP was already providing good nesting habitat for ring-necked pheasants and meadowlarks; (3) plantings of woody plants, food plots, and persistent herbaceous vegetation were encouraged for pheasants; and (4) mowing and haying likely affected pheasant and meadowlark nesting in 1988 and subsequently in 1989, year after mowing.

Hays, R. L., R. P. Webb, and A. H. Farmer. 1989. Effects of the Conservation Reserve Program on wildlife habitat: results of 1988 monitoring. Transactions of the North American Wildlife and Natural Resources Conference 54:365-376.

Highest amount of persistent vegetation cover was on CP2 (warm-season grasses) fields. Highest pre-green up average Visual Obstruction Reading was on CP2. Percentage of herbaceous cover made up of grasses was no different between conservation practices. CRP appears to be providing good nesting habitat for pheasants and fair nesting habitat for meadowlarks. Improvement in habitat quality for cottontails was not detected. Winter cover values appeared to be greater in CP2 than in CP1 (introduced grasses) stands. In northern areas, pheasant responses to CRP may be influenced by availability of winter food and cover. Authors recommended establishment of woody vegetation and food plots in areas where winter food and cover were limiting for pheasants.

Heimlich, R. E., and C. T. Osborn. 1993. After the Conservation Reserve Program: Macroeconomics and post-contract program design. Great Plains Agricultural Council Annual Meeting. June 2-4, 1993, Rapid City, South Dakota.

Heimlich, R., C. T. Osborn, and A. W. Allen. 1994. Including wildlife in an environmental benefits index (EBI) for analyzing alternative acreage reduction scenarios when CRP contracts expire. American Agricultural Economists Meeting, August 1993, Orlando, Florida. 8 pp.

Heimlich, R., C. T. Osborn, A. W. Allen, and R. Roath. 1994. What do we have to lose? Pages 13-15 *in* R. Clark, editor. Future use of Conservation Reserve Program lands in the Great Plains. University of Nebraska, Lincoln.

Henry, J. J. 1986. Ring-necked pheasant response to habitat improvements. Ohio Department of Natural Resources, Division of Wildlife. Federal aid in wildlife restoration final report for projects W-301-R-72 through R-92. 37 pp.

To maximize benefits of habitat improvements in intensive management areas, land use patterns and habitat deficiencies must be identified at township and section levels. Ideally, pheasant nesting cover should only be established in areas within one-quarter mile of secure winter cover. Minimum habitat goal should be improvement of 4% of area (25 acres/section or 900 acres/township).

Herkert, J. R. 1991. Prairie birds of Illinois: Population response to two centuries of habitat change. Illinois Natural History Survey, Bulletin from Symposium Proceedings: Our Living Heritage 34:393-398.

Herkert, J. R. 1994. Breeding bird communities of midwestern prairie fragments: The effects of prescribed burning and habitat area. Natural Areas Journal 14: 128-135.

Study compared the effects of habitat area and prescribed burning on breeding bird communities using midwestern prairie fragments. Habitat area had a much greater influence on the composition of the breeding bird community than prescribed burning. Large prairie fragments must be managed to provide a mosaic of burned and unburned areas to ensure that suitable habitat is available for species experiencing significant population declines and requiring large grassland areas. Benefits of burning include increase in above-ground plant biomass, which may provide greater nest concealment and reduced predation. Densities of insects were greater in burned than in unburned prairies. Management of large fragments of prairie is more complex than that of smaller fragments due to the presence of burn-sensitive species. The habitat requirements of burn-sensitive species can be addressed by providing a mosaic of habitat types. Author suggested that prescribed burns be conducted on large prairie fragments (> 80 ha) on three- to five-year rotation with 20-30% of area burned annually. On small fragments, a larger percentage may be burned, but < 50-60% of area should be burned annually, especially if burn-sensitive species are present.

Herkert, J. R. 1994. The effects of habitat fragmentation on midwestern grassland bird communities. Ecological Applications 4:461-471.

Study evaluated the effects of habitat fragmentation on midwestern grassland bird communities. Both area and vegetation structure significantly influence midwestern grassland bird communities. Species richness of breeding birds significantly increased with fragment size. Occurrences of eight of 15 bird species were influenced by habitat area. Estimates of minimal area requirements for five area-sensitive species ranged from five to 55 ha. Absence of area-sensitive grassland bird species from some small fragments may result from limited availability of habitat. All five area-sensitive species regularly avoided small grassland fragments that otherwise were suitable. Habitat fragmentation likely contributed to declines in area-sensitive grassland birds in the Midwest. Author recommended that management seek to minimize disturbances during the breeding season and control features, such as woody encroachment, that attract nest predators and brood parasites. Special attention given to area-sensitive species would be of general benefit to all grassland birds. Author cautioned that local or regional extinctions were likely if loss and fragmentation of grassland habitats continues in Midwest.

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

Author attempted to determine (1) whether CRP has had a measurable, widespread, population-level effect on population trends for grasshopper sparrows in the mid-continental United States, and (2) whether such trends were related to the amount of CRP in the local landscape. Analysis indicated that CRP had widespread, population-level influence on grasshopper sparrows in the mid-continental United States. BBS route slopes for grasshopper sparrows significantly increased from pre- to post-CRP periods. Differences in individual route slopes were related to local CRP enrollment.

Herkert, J. R., 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, North Central Forest Experiment Station, General Technical Report NC-187.

Avian species of high priority for conservation were associated with a variety of grassland habitats, including dry prairies, pastures, old fields, hayfields, wet prairies, sedge meadows, and grasslands with interspersed shrubs. Diverse habitat associations of bird species of high management concern suggested that problems facing grassland birds were widespread and involved a variety of grassland habitats. One common feature was sensitivity to habitat fragmentation. Declines in grassland bird numbers significantly correlated with declines in regional acreages of pastures and hayfields. Nest success of grassland birds was highest two to three years following prescribed fire. Three- to five-year rotational burning appears to be optimum under most circumstances. Authors indicated that our understanding of winter ecology and habitat requirements of grassland bird species was incomplete. Relatively few avian species used fields with monotypic grass cover. Pastures were the region's most abundant grassland habitat accounting for 7.8 million ha or 5.7% of land area. Pastures provided important habitat because when they were not overgrazed, they supported diverse assemblages of grassland bird species, including those with declining populations. Pasture/hayfield acreage reached a peak in Midwest in early 1900s.

Large scale, diverse grassland management is needed to meet the habitat needs of migratory grassland bird species of the greatest conservation concern in Midwest region. Habitats of highest management concern will vary regionally. Management should focus on providing habitat for large populations of area-sensitive species to increase the likelihood of long-term persistence of populations.

Herman, R. J. 1993. Wildlife management on CRP. U.S. Department of Agriculture, Soil Conservation Service. Illinois Bulletin No. Ill90-3-33.

Higgins, K. F. 1987. Maintenance of planted grass stands for wildlife. Proceedings of the North Dakota Academy of Science 41:42.

Higgins, K. F., D. E. Nomsen, and W. A. Wentz. 1987. The role of the Conservation Reserve Program in relation to wildlife enhancement, wetlands, and adjacent habitats in the northern Great Plains. Pages 99-104 *in* J. E. Mitchell, editor. Impacts of the Conservation Reserve Program in the Great Plains. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-158.

General treatments of anticipated wildlife-related benefits and problems associated with CRP in Great Plains. Potential uses of CRP grasslands after expiration of contracts were discussed. Authors recommended (1) following CRP standards during contract period, especially with respect to disturbance during the critical nesting period (Apr. 20-Aug. 1); (2) USDA action to encourage reenrollment in program; (3) enforcing mandatory standards for site-adapted/wildlife-friendly seeding mixtures; (4) encouraging wetland restoration on CRP lands; and (5) adopting compatible land uses.

Hoefer, P., and G. F. Bratton. 1987. The role of trees and shrubs as economic enterprises and wildlife habitat development in the Great Plains. Pages 109-112 *in* J. E. Mitchell, editor. Impacts of the Conservation Reserve Program in the Great Plains. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-158.

Authors maintain that trees and shrubs add performance to CRP and that there are measurable long-term economic and aesthetic advantages to tree planting for wildlife habitat. General information presented on CRP regulations for tree planting, roles of CP3 and CP5, and economic benefits of wildlife habitat development in CRP.

Homan, H. J., G. M. Linz, and W. Bleier. 2000. Winter habitat use and survival of female ring-necked pheasants (*Phasianus colchicus*) in southeastern North Dakota. American Midland Naturalist 143:463-480.

Study monitored winter habitat selection and survival of female pheasants in southeastern North Dakota. Relatively heavy snows forced pheasants from upland CRP grassland cover into cattail cover associated with large Class IV wetlands. CRP grasslands in study area often contained wetlands that became foci of wintering pheasants during milder periods of winter weather. CRP grassland cover became unsuitable in more severe snow periods when cover in upland and small, embedded wetlands became snow-packed.

Horn, D. J. 2000. The influence of habitat features on grassland birds nesting in the Prairie Pothole Region of North Dakota. Ph.D. dissertation. Iowa State University, Ames.

Study conducted in North Dakota Prairie Pothole Region examined how landscape composition influenced relations among (1) occurrence and abundance of grassland songbirds and field size, and (2) nest success of ducks, field size, and edges. Landscape composition influenced relations between field size and relative abundance of three grassland songbird species. As amount of grassland in landscape increased, the species abundance in smaller fields increased. Duck nest success increased with field size and was greater in study areas with 51-55% grassland than in 15-20% grassland. Positive relation between nest success and distance to edge in 50-51% grassland, but no relationship in 15-20% grassland.

Hubbard, M. W. 1991. Habitat changes in central Iowa and their relationship to ring-necked pheasant populations, 1981-1990. M.S. thesis. Iowa State University, Ames. 64 pp.

Study examined habitat changes in central Iowa and their relationship to ring-necked pheasant populations between 1981 and 1990. Habitat Suitability Index (HSI) model was evaluated by relating outputs to pheasant numbers using multiple regression. Pheasant numbers were negatively related to alfalfa/hay acreage and positively related to pasture lands. Area in roadside and spring VOR was positively related to pheasant numbers. Original HSI model lacked critical winter food element. Consequently, three variables: disked corn, chiseled corn, and disked soybeans were incorporated into the model. Widespread declines in pheasant populations in the northern Plains states since the 1960s were attributed to habitat loss associated with increased mechanization and conversion of noncrop acreage to croplands.

Hull, S. D. 1993. Avian, invertebrate, and forb abundance in Conservation Reserve Program fields in northeast Kansas with notes on avian behavior. M.S. thesis. Kansas State University, Manhattan. 141 pp.

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

Comparison of invertebrate abundance in six Kansas CRP fields. Analysis did not detect significant relationships between forb abundance and invertebrate biomass or avian abundance, or between avian abundance and invertebrate biomass. Avian species richness did not vary with forb abundance. Authors suggested that findings did not support or reject commonly held assumption that increasing forb component in CRP fields planted to native grasses will enhance invertebrate biomass and avian abundance. Authors speculated that small sample size and low range of forb abundance in fields (0 to 23%) may have influenced study results and suggested that future studies increase number of fields sampled and range of forb abundance in fields sampled.

Hughes, J. P., R. J. Robel, K. E. Kemp, 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.

Study examined the effects of habitat on dickcissel abundance and nest success in Kansas CRP fields dominated (95%) by Indiangrass, big bluestem, little bluestem, side-oats, switchgrass, and western wheatgrass. Dickcissel abundance was associated significantly with field-level vegetation characteristics, field edge characteristics, and land use surrounding CRP fields. Nest success was associated with field-level vegetation variables only, specifically those associated with vegetation volume. Daily nest survival was associated with

litter cover and live and dead canopy covers. Forbs have been recognized as preferred nesting substrates, but forbs were relatively uncommon in CRP fields evaluated in this study. Habitat quality of CRP fields might be enhanced for dickcissels by modifying vegetative characteristics of fields.

Hurley, R. J., and E. C. Franks. 1976. Changes in the breeding ranges of two grassland birds. Auk 93: 108-115.

Changes in the ranges of the dickcissel and horned lark were attributed to man-made environmental changes. Dickcissels were attracted to alfalfa, but this cover was a biological trap because harvesting typically coincided with prime nesting period.

Hurley, T. M., B. A. Babcock, R. E. Reynolds, and C. R. Loesch. 1996. Waterfowl populations and the Conservation Reserve Program in the Prairie Pothole Region of North and South Dakota. Iowa State University, Center for Agricultural and Rural Development, Working Paper 96-WP-165. 30 pp.

Study attempted to estimate CRP contributions to waterfowl conservation in the Prairie Pothole Region of North and South Dakota. Density of breeding pairs of waterfowl under current distribution of CRP was only 12.5% greater than what would have been realized if land had been randomly enrolled in the program. Authors suggested that old enrollment rules did a relatively poor job of targeting the best waterfowl habitat. They projected that improved targeting of CRP would double benefits for waterfowl. Additional benefits would be realized if priority was given to Wetland Management Districts that had quality waterfowl habitat. Benefits of such targeting would extend to other wildlife species as well as waterfowl. To maximize program benefits for wildlife, they recommended that targeting efforts focus on multiple county areas rather than regions.

Igl, L. D., and D. H. Johnson. 1995. Dramatic increase of Le Conte's sparrow in Conservation Reserve Program fields in the northern Great Plains. Prairie Naturalist 27:89-94.

Use of CRP fields by Le Conte's sparrows increased from 1990-1993 to 1994. Changes in the abundance of Le Conte's sparrows was associated with above normal precipitation from mid-1993 to mid-1994 that likely produced favorable breeding conditions for this species in CRP fields. Results suggested that the CRP fields may be important breeding habitat for species only under certain conditions (i.e., wet) and that use of these fields for emergency haying or grazing could negatively impact such species. Authors indicated that such impacts had not been studied sufficiently to draw any conclusions.

Igl, L. D., and D. H. Johnson. 1995. Migratory bird population changes in North Dakota. Pages 298-300 *in* E. T. LaRoe, G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac, editors. Our living resources: A report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. U.S. Department of the Interior, National Biological Service. Washington, D.C.

Review of the status and trends for 160 bird species recorded breeding in 128 quarter-sections located throughout North Dakota in 1967, 1992, or 1993. Authors summarized distribution of species by breeding habitat and migration strategy, number of indicated pairs by survey year for the 50 most abundant species, and number of indicated pairs by survey year, habitat, and migratory strategy.

Igl, L. D., and D. H. Johnson. 1999. Le Conte's sparrows breeding in Conservation Reserve Program fields: Precipitation and patterns of population change. Studies in Avian Biology 19:178-186.

Breeding Le Conte's sparrows were studied in CRP grassland from 1990 to 1996. Status changed from an uncommon breeding species to one of the most abundant species recorded in last two years of study. Results emphasized the importance of range-wide conservation efforts and long-term observations of grassland birds. In six-year study period, 111 species of birds were recorded using CRP grasslands during the breeding season. Dramatic increase in populations of this sparrow coincided with occurrence of wet conditions in the northern Great Plains. Authors concluded that geographically large conservation programs such as the CRP were important for long-term conservation of grassland birds.

Igl, L. D., and L. A. Murphy. 1996. CRP, succession, and Brewer's sparrows: Advantages of a long-term, federal land retirement program. South Dakota Bird Notes 48:69-70.

Isaacs, B., and J. D. Howell. 1988. Opportunities for enhancing wildlife benefits through the Conservation Reserve Program. Transactions of the North American Wildlife and Natural Resources Conference 53:222-231.

Based on a review of first five CRP sign-ups, the authors recommended that communication and cooperation between USDA and wildlife agencies be expanded and suggested that low-level, extensive wildlife habitat improvement would have greater benefits than intensive management on small acreages.

Jahn, L. R. 1988. The potential for wildlife habitat improvements. Journal of Soil and Water Conservation 43:67-69.

General discussion of multiple benefits of integrated agricultural and conservation programs.

Jahn, L. R., and E. W. Schenck. 1990. U.S. agricultural programs: Implications for wildlife and potential for improvement. Pages 359-371 *in* K. E. Church, R. E. Warner, and S. J. Brady, editors. Perdix V: Gray partridge and ring-necked pheasant workshop. Kansas Department of Wildlife and Parks, Emporia.

Jahn, L. R., and E. W. Schenck. 1991. What sustainable agriculture means for fish and wildlife. Journal of Soil and Water Conservation 46:251-255.

General discussion of potential Farm Bill contributions to sustainable agriculture and implications of the Farm Bill for fish and wildlife.

Jassen, L., M. Beutler, and T. Ghebremicael. 1994. Major characteristics of post-contract land use intentions for Conservation Reserve Program wetland tracts. South Dakota State University, Economics Staff Paper No. 94-2.

Jewett, G., C. C. Sheaffer, R. D. Moon, N. P. Martin, D. K. Barnes, D. D. Breitbach, and N. R. Jordan. 1996. A survey of CRP land in Minnesota: I. Legume and grass persistence. Journal of Production Agriculture 9:528-534.

Evaluation of vegetation in 151, six- to eight-year-old CRP fields planted to cool- and warm-season grasses in Minnesota. Legumes, mostly alfalfa and birdsfoot trefoil, persisted in 82% of CP1 field planted to legumes with 23% ground coverage. Authors recommended periodic mowing or development of persistent cultivars to maintain legumes in CRP fields. Alsike clover, red clover, and sweetclover did not persist in undisturbed fields.

Jewett, G., C. C. Sheaffer, R. D. Moon, N. P. Martin, D. K. Barnes, D. D. Breitbach, and N. R. Jordan. 1996. A survey of CRP land in Minnesota: II. Weeds on CRP land. Journal of Production Agriculture 9:535-542.

Evaluation of the prevalence of undesirable broad-leafed herbaceous plants (weeds) in 151, six- to eight-year-old CRP fields planted to cool- and warm-season grasses in Minnesota. Most prevalent weeds were Canada thistle, quackgrass, dandelion, and goldenrod. Cover of weeds was higher in CP10 fields than in CP1 or CP2 fields. Legume and grass groundcover usually was negatively correlated with weed groundcover. Authors indicated that widespread occurrence of noxious weeds in CRP fields was a cause for concern and should be addressed in future CRP planning.

Johnson, D. H., S. D. Haseltine, and L. M. Cowardin. 1994. Wildlife habitat management on the northern prairie landscape. Landscape and Urban Planning 28: 5-21.

Summary of European settlement impacts to northern prairie landscapes and wildlife habitat. Regional management of wildlife can not be effective on public lands alone. Partnerships with private landowners need to be developed. Wildlife managers need to base management activities on explicit, quantifiable objectives that furnish measures of survival, reproduction, and distribution of species. Descriptions of potential landscape-level management options were presented.

Johnson, D. H., and L. D. Igl. 1995. Contributions of the Conservation Reserve Program to populations of breeding birds in North Dakota. Wilson Bulletin 107:709-718.

Evaluation of projected changes in North Dakota breeding bird populations if CRP land was converted back to agricultural production. Of 18 species common on CRP, crop fields, or both, 12 were more abundant in CRP. Six of these species had suffered significant decline in populations. None of species common in cropland cover types had declined significantly. Termination of CRP and return of lands to cultivation projected to cause population declines for sedge wren, grasshopper sparrow, savannah sparrow, dickcissel, and lark bunting. The authors concluded that CRP not only provided important breeding habitat for grassland birds, but also may be a means to restore abundant populations of these species.

Johnson, D. H., and R. R. Koford. 1995. Conservation Reserve Program and migratory birds in the northern Great Plains. Pages 302-303 *in* E. T. LaRoe, G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac, editors. Our living resources: A report to the nation on the distribution, abundance, and health of U.S. plant, animal, and ecosystems. U.S. Department of the Interior, National Biological Service. Washington, D.C.

Presentation of nest densities and survival rates for selected common birds and waterfowl nesting in North Dakota and Minnesota CRP fields, croplands, and waterfowl production areas. Data supports conclusion that federal agricultural programs can have beneficial effects on wildlife resources over broad geographic areas. As CRP fields age, their attractiveness to certain species may change.

Johnson, D. H., and M. D. Schwartz. 1993. The Conservation Reserve Program: Habitat for grassland birds. Great Plains Research 3:263-295.

This paper discussed the grassland bird populations found in CRP fields in western Minnesota, North Dakota, South Dakota, and eastern Montana from 1990 to 1992. The study evaluated population responses of a number of grassland birds to different conservation practices established in CRP fields. In terms of overall breeding bird densities, no one conservation practice was found to be uniformly better than another. Particular cover practices favored certain species. The authors concluded that CRP fields provided habitat for a wide array of grassland birds and that CRP had the potential to reverse the population declines for several species.

Johnson, D. H., and M. D. Schwartz. 1993. The Conservation Reserve Program and grassland birds. Conservation Biology 7:934-937.

Authors evaluated breeding bird use of CRP fields in North Dakota, South Dakota, eastern Montana, and western Minnesota during the 1990 and 1991 nesting seasons. They compared their findings with trends from Breeding Bird Survey records for 1966 through 1990. They recorded 73 bird species using CRP fields. The most abundant birds, in order of abundance, were lark bunting, grasshopper sparrow, red-winged blackbird, western meadowlark, and horned lark. Several prairie bird species declining in abundance from 1966 to 1990 were common in CRP fields. Early results suggested that restored grasslands were supporting a wide variety of grassland birds, some of which had experienced dramatic declines in the past 30 years.

Johnson, G. J., and S. A. Temple. 1990. Nest predation and brood parasitism of tallgrass prairie birds. Journal of Wildlife Management 54:109-111.

Rates of nest predation and brood parasitism for five species of birds nesting in fragments of tallgrass prairie in Minnesota were affected by the size of the prairie fragment, distance to wooded edge, and number of growing seasons since vegetation around nest was last burned. Rates of nest predation were reduced in larger habitats, away from wooded edges, and in vegetation burned less than three years. Management to maximize nest productivity should focus on provision of large fields, regular burning, and removal of wooded edges. Species investigated included clay-colored sparrow, savannah sparrow, bobolink, grasshopper sparrow, and western meadowlark. Because of increased abundance of cowbirds and addition of wooded edges to prairie habitat, nest productivity of prairie nesting birds may be declining. Authors speculated that tall, dense vegetation in recently burned prairies reduced visibility of nests and restricted predator movements. Additionally, increased production of seeds and insects in recently burned areas may have reduced time spent foraging and increased time available to attend nests.

Johnson, R., E. Ekstrand, J. R. McKean, and K. John. 1994. The economics of wildlife and CRP. Pages 45-51 *in* When Conservation Reserve Program contracts expire: The policy options. Soil and Water Conservation Society, Ankeny, Iowa.

Author stated that net taxpayer outlay was one way to evaluate the cost effectiveness of the CRP. Reduced farm production expenditures from CRP have raised some concerns for local rural communities. The author suggested that negative economic impacts were partially offset by increases in wildlife-related economic activities such as hunting, bird watching, or fishing. The author determined that taxpayer outlay for the first 11 CRP sign-ups was $8.9 billion; wildlife economic benefits totaled $8.6 billion, and total benefits (including water quality) was $13.4 billion. The author concluded that CRP was economically beneficial for participating producers and society.

Johnson, R. G., and S. A. Temple. 1986. Assessing habitat quality for birds nesting in fragmented tallgrass prairies. Pages 245-249 *in* J. Verner, M. L. Morrison, and C. J. Ralph, editors. Wildlife 2000: Modeling habitat relationships of terrestrial vertebrates. University of Wisconsin Press, Madison.

Johnson, R. J., and M. M. Beck. 1988. Influences of shelterbelts on wildlife management and biology. Agric. Ecosystems Environ. 22/23:301-335.

Comprehensive review of bird and mammal use of shelterbelts as shelter, escape or refuge cover, foraging sites, reproductive habitat, and travel corridors. Shelterbelts have contributed to range expansion of some small mammals and birds. Numbers and diversity of wildlife were positively correlated with area, perimeter length, adjacent land uses and vegetative diversity and complexity. Authors concluded that practice provided economic, educational, recreational, and aesthetic benefits with minimal wildlife damage or nuisance problems to adjacent areas.

Johnson, R. L., J. R. McKean, C. L. Sandretto. 1992. Increased recreational hunting can offset negative economic impacts of the Conservation Reserve Program. U.S. Department of Agriculture, Economic Research Service/Technical Bulletin TB92-4. 23 pp.

Analysis of National Survey of Fishing and Hunting data for northeastern Colorado estimated the increase in small game and migratory bird hunting needed to offset negative economic effects of the CRP. Authors estimated that income from recreational uses would need to increase 1.8- to 2.5-times to offset negative economic effects of the CRP. Adverse economic impacts of CRP would sharply increase if participants left the region.

Jones, L. A., and A. D. Kruse. 1995. The northern Great Plains - Wildlife goals and objectives for the 1995 Farm Bill. Transactions of the North American Wildlife and Natural Resources Conference 60:307-314.

Authors provided general review of land use changes since settlement and impacts of these changes on bird populations in northern Great Plains. Regional goals were presented for selected wildlife groups (waterfowl, other wetland birds, gray partridge, pheasants, prairie grouse, raptors, nongame birds, fisheries, and big game) and grassland, wetland, and riparian aquatic habitats.

Joyce, L. A., J. E. Mitchell, and M. D. Skold, editors. 1991. The Conservation Reserve - yesterday, today and tomorrow: Symposium. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-203. 64 pp.

Proceedings of symposium held in conjunction with the Society of Range Management. Topics were wide-ranging, following themes of CRP impacts on people and resources in 10 Great Plains states where 50% of program is located.

Joyce, L. A., and M. D. Skold. 1987. Implications of changes in the regional ecology of the Great Plains. Pages 115-127 *in* J. E. Mitchell, editor. Impacts of the Conservation Reserve Program in the Great Plains. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-158.

Paper examined CRP in context of environmental, economic, and ecological changes in Great Plains. Authors concluded that (1) benefits of retiring Great Plains cropland for soil erosion were reduced compared to other regions; (2) 10-yr contracts were more beneficial for wildlife than annual diversions and conservation compliance measures; and (3) impact of CRP (up to 20 million acres) will be dwarfed by future land use changes that will result in 100 million acres being taken out of production in Great Plains by 2000.

Just, R. E., and J. M. Antle. 1990. Interaction between environmental and agricultural policies: Opportunities for coordination and limitations for evaluation. American Economic Review 80:197-202.

Agricultural policy has had a well-documented impact on farmers' production decisions, which in turn has affected the environment. The public's perception is that existing agricultural policies are linked to agricultural pollution. Existing agricultural and environmental policies can have either positive or negative effects on non-point source pollution. Agricultural policy can be used to mitigate pollution if properly implemented. Agricultural production and environmental impacts depend on site-specific environmental conditions. Authors concluded that generalizations about the environmental impacts of agricultural policies were easy to make but that they should be avoided.

Kantrud, H. A. 1981. Grazing effects on avifauna of North Dakota. Canadian Field-Naturalist 95:404-417.

Avian species richness tended to decrease in response to greater grazing intensity, but total bird density increased due to higher populations of a few species. Total bird density was always highest on idle or lightly grazed sites. In general, distribution and abundance of most grassland bird species in North Dakota have been negatively affected by agricultural and pastoral activities. Fragmentation of grasslands by agriculture resulted in extirpation of some species; effects of cultivation on grassland birds have been greatest in the eastern tallgrass prairie region where extensive habitat loss has occurred. Author advocated protection for remaining areas of grassland representative of the region. Periodic management will be required for long-term preservation.

Kantrud, H. A. 1993. Duck nest success on Conservation Reserve Program land in the Prairie Pothole Region. Journal of Soil and Water Conservation 48: 238-242.

Duck nest success was higher (23.1%) on CRP tracts than on Waterfowl Production Areas (8.2%). Larger field size, greater distance from water, lower nest densities, and good vegetative cover on CRP fields contributed to lower rates of predation.

Kantrud, H. A., and K. F. Higgens. 1992. Nest and nest site characteristics of some ground-nesting, non-passerine birds of northern grasslands. Prairie Naturalist 24:67-84.

Fields with numerous wetlands were more attractive to upland-nesting shorebirds than were similar fields where wetlands were more distant. All species studied used native grassland for nesting. Fourteen species nested in seeded grasslands and croplands. Nest success rates did not differ among habitat types for any species. Except for killdeer, few nests were in annually tilled croplands. Recommendations for pasture management of mixed-grass prairies in North Dakota were provided.

Kantrud, H. A., and R. L. Kologiski. 1982. Effects of soils and grazing on breeding birds of uncultivated upland grasslands of the northern Great Plains. U.S. Fish and Wildlife Service. Wildlife Research Rept. 15. 32 pp.

Livestock grazing on lands set aside for wildlife can be used as a management measure to increase populations of game species and increase diversity of plant or animal species. Light to moderate grazing resulted in increased species richness. Species richness was significantly reduced by heavy grazing in the northern Great Plains. Grazing by domestic livestock generally decreased average vegetative height and increased exposure of bare soil; in lightly grazed plots, height of vegetation seemed to decrease because of shading effect of large amounts of litter. Increased richness was associated with plots in which the height of vegetation was not appreciably reduced and the percentage of bare soil not greatly increased by excessive grazing.

Kaufman D. W., and G. A. Kaufman. 1989. Nongame wildlife management in central Kansas: implication of small mammal use of fencerows, fields, and prairie. Transactions of the Kansas Academy of Science 92: 198-205.

Prairie-cropland ecotone provides suitable habitat for several native small mammals. Fencerows between prairie and cropland supported an abundant, diverse assemblage of native small mammals. The association of these species was apparently dependent on tall, dense vegetation, deep litter, and ready access to food in cropfields. Interiors of cropland, even when fallow, were insufficient to support most species of small mammals. Establishment of small ungrazed herbaceous and woody habitats scattered within the matrix of cultivated fields would enhance small mammal density and diversity.

Keeland, B. D., J. A. Allen, and V. V. Burkett. 1995. Southern forested wetlands. Pages 216-218 *in* E. T. LaRoe, G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac, editors. Our living resources: A report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. U.S. Department of the Interior, National Biological Service. Washington, D.C.

Review of presettlement conditions, current status, causes of loss, and future prospects for forested wetlands in southern United States.

Kelly, C. R., and J. A. Loden. 1995. Federal farm program conservation initiatives: Past, present, and future. Natural Resources & Environment 9:17-19.

From its New Deal beginnings, farm policy has been primarily designed to stabilize commodity prices and to support farm income. Natural resources capital on which agriculture is dependent has not been the primary concern of those who have guided federal farm policy for the past 60 years. Conservation initiatives have largely served to gain political support or otherwise assist in achieving a given program's economic objectives. Although economic well-being will always be the predominant concern of federal policy, conservation is likely to assume greater importance. Budgetary constraints and international competition will accelerate market-orientated policies. Paying farmers for adopting conservation practices is likely to expand, replacing other mechanisms for supporting farm income.

Authors discussed politics associated with green payments; namely, favored recipients of green payments are not likely to be the same farmers favored by current income transfers. Program may not provide benefits to small farmers because attention may be directed at those who farm the most land. Also, income from green payments may be insufficient to interest farmers.

Kennedy, C. L., and K. F. Higgins. 1995. Effects of grazing on nongame breeding birds, insects, and vegetation in Conservation Reserve Program grasslands in North Dakota. Annual Meeting of the Society of Range Management 48:32-33.

Kessler, W. B., H. Salwasser, C. W. Cartwright, Jr. , and J. A. Caplan. 1992. New perspectives for sustainable natural resources management. Ecological Applications 2:221-225.

Management of public lands and resources requires that managers (1) respond to more complex views of public lands and their roles in meeting human needs and aspirations; (2) define objectives that relate to ecological and aesthetic conditions of the land and desired future condition of public lands necessary to sustain land uses and resource yields; (3) recognize that grasslands are sustainable in nature by dynamic forces such as fire, flood, and grazing. (These forces continually change vegetation patterns and processes having major effects on biological diversity, water quality, and other values.)

The public must be fully informed about the conditions, capabilities, and options for lands and resources and share in knowledge that professionals accrue through research and management experience. Science must take into consideration the values and needs of people rather than concluding what is good or bad for society from their own technical perspectives. Changes in perspectives must address cumulative effects of management and landscape fragmentation. Ecosystems must be looked at as a whole rather than individual parts.

Kimmel, R. O., A. H. Berner, R. J. Welsh, B. S. Haroldson, and S. B. Malchow. 1992. Population responses of gray partridge (*Perdix perdix*), ring-necked pheasants (*Phasianus colchicus*), and meadowlarks (*Sturnella* spp.) to farm programs in Minnesota. Giber Fauna Sauvage 9:797-806.

King, J. W. 1991. Effects of the Conservation Reserve Program on selected wildlife populations in southeast Nebraska. M.S. thesis. University of Nebraska, Lincoln. 39 pp.

Study conducted in southeast Nebraska compared wildlife populations areas with high and low CRP enrollments. Pheasant population showed a positive response to nesting, loafing, and roosting cover furnished by CRP plantings. CRP grasslands enhanced habitat quality for nongame birds by providing nesting and brood-rearing cover in agricultural landscapes where such cover was absent prior to the program. Effects of CRP on eastern cottontail populations unclear. Author speculated that habitat quality for nongame birds would decline in CRP grasslands planted to single species of grass as they matured. He recommended periodic disturbance (e.g., burn every three to five years) of CRP fields to maintain desirable features of vegetation composition.

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.

Pheasant numbers in southeastern Nebraska were higher in areas with approximately 20% CRP enrollment than in areas with < 5% CRP enrollment. Meadowlark numbers and cottontail numbers did not differ between areas. No differences were found between numbers of birds or avian richness between cool-season and warm-season cover types. Author interpreted the lack of a relationship between bird numbers and vegetation diversity as evidence that vegetative structure and amount of cover were more important than plant diversity. Vegetation generally was taller in warm-season than in cool-season plantings. Author suggested that fields be burned every three to five years. Habitat quality of fields seeded with a single grass species generally declined as vegetation matured and became more dense.

Kirsch, L. M., H. F. Duebbert, and A. D. Kruse. 1978. Grazing and haying effects on habitat of upland nesting birds. Transactions of the North American Wildlife and Natural Resources Conference 43:486-497.

Extensive review of effects of grazing and haying on upland nesting ducks, game birds, and nongame birds. Strong positive relationships between height-density of undisturbed vegetation and duck nest densities and nesting success demonstrated for North Dakota study site. Authors strongly recommended against annual grazing and haying.

Klett, A. T., H. F. Duebbert, and G. L. Heismeyer. 1984. Use of seeded native grasses as nesting cover by ducks. Wildlife Society Bulletin 12:134-138.

Study conducted in North Dakota (1970-1973) compared duck nesting activity in unplowed native prairie to fields seeded native grasses or introduced grasses and legumes. Nest survival did not vary among cover types, but nest density was reduced in native prairie compared to native and nonnative plantings.

Klett, A. T., T. L. Shaffer, and D. H. Johnson. 1988. Duck nest success in the Prairie Pothole Region. Journal of Wildlife Management 52:431-440.

Nesting success estimated for five species of dabbling ducks nesting in eight habitat types in the Dakotas and Minnesota, 1964-1984. Nesting success rates ranged from < 5 to 36%, but varied among regions, periods, and species. Nests located in idle grassland were most successful; cropland nests were least successful. Mammals were major cause of nest failure, but farming operations resulted in 24% loss in haylands and 37% loss in cropland. Observed recruitment rates generally were below levels necessary to sustain populations.

Klute, D. S. 1994. Avian community structure, reproductive success, vegetative structure, and food availability in burned CRP fields and grazed pastures in northeastern Kansas. M.S. thesis. Kansas State University, Manhattan. 168 pp.

Study compared avian community structure and reproductive success, vegetative structure, and food availability in CRP fields with native grasslands that were burned and grazed. During summer, the relative abundance of avian species was greater in grazed native grasslands than in CRP fields. Differences in bird communities were attributed vegetative characteristics. Specifically, vegetative height and biomass (VOR) were greater in CRP than grazed native grasslands. Total invertebrate biomass during summer was significantly greater in grazed native grasslands than in CRP. Author suggested that high invertebrate abundance was related to greater forb coverage in grazed native grasslands. During winter, relative avian abundance did not differ between CRP and grazed native grasslands, but species richness greater in CRP that had taller vegetation and more bare ground than grazed native grasslands. Total biomass of available seed did not differ between CRP and grazed native grasslands; however, CRP contained more preferred food items. Author concluded that CRP provided better winter habitat. He suggested that moderate grazing, contributing to reduced vegetative height, increased total canopy coverage, and increased forb coverage, may improve CRP fields for grassland birds.

Klute, D. S., and R. J. Robel. 1993. Comparative avian usage of rowcrop, burned and unburned CRP fields, and grazed pastures in eastern Kansas. Horned Lark 20:4 (abstract only).

Klute, D. S., R. J. Robel, and K. E. Kemp. 1997. Seed availability in grazed pastures and Conservation Reserve Program fields during winter in Kansas. Journal of Field Ornithology. 68:253-258.

Study compared seed abundance in CRP fields and grazed native pasture in Kansas in winter. Seed abundance in CRP fields differed between winters and changed seasonally; biomass was greater than that in grazed pasture in one of two years. Authors concluded that CRP fields were superior to grazed native grasslands as winter habitat for birds.

Knopf, F. L. 1986. Changing landscapes and the cosmopolitanism of the eastern Colorado avifauna. Wildlife Society Bulletin 14:132-142.

Development of riparian forests on the Great Plains has provided corridors for movement of forest birds across grasslands that have historically served as ecological barriers to their dispersal. This example illustrates the relevance of current conservation theory to decisions on local management and the need for regional management plans.

Knopf, F. L. 1988. Conservation of steppe birds in North America. ICBP Technical Publication No. 7: 27-41.

Only nine avian species are wholly endemic to the tall- and shortgrass prairies. An additional 19 species have strong affinities to the grasslands but also occur in adjacent vegetation types. Endemic species spend entire year within the grassland; the remaining species tend to migrate into brushland and other habitats in Mexico and Central America. About 260 species of birds regularly breed in the grasslands of North America; however, most are associated with wetlands or man-altered landscapes. Locally, bird communities within grassland average only three to five species during the breeding season with substantial seasonal and annual variation in densities. Invasion of steppe by woody plants provides habitat for birds more typical of eastern deciduous forests; mixing of avifaunas has occurred at the potential expense of primary and most secondary species of steppe birds. Land acquisition programs should identify the needs of the area-sensitive stenotopic species for a site when planning steppe purchases.

Knopf, F. L. 1992. Faunal mixing, faunal integrity, and the biopolitical template for diversity conservation. Transactions of the North American Wildlife and Natural Resources Conference 57:330-342.

At many locations, local species assemblages have been affected by the addition of new species from contiguous or distant sites. Often augmented faunas are viewed positively by the public and management agencies, but shifts in the composition of native biological diversity can lead to declines in regionally unique species. Faunal mixing is a dilemma for biologists dedicated to protecting the integrity of native, endemic faunas. Dichotomy exists for managers between preserving the biological diversity of and enhancing vertebrate populations. Traditional policies of natural resource agencies have favored the spread of ecological-generalist species across landscapes. Most popular game species are characteristic of early successional habitats. These species typically respond favorably to greater edge and habitat diversity. Enhancing species richness through fragmentation in landscape is no longer favored and growing evidence suggests that increasing the quantity of edge can harm the composition of some wildlife communities. Ecological consequences of species substitutions are masked in management that focuses purely on species richness. Conservation of biological diversity must complement the conservation of endangered species. Despite the extinction of many species and a general decline in the biological diversity of North America, many local faunas contain more species today than historically present. Species introductions and range expansions into altered landscapes have augmented local species richness. Future conservation of faunal integrity requires enhanced coordination among natural resource agencies.

Knopf, F. L. 1994. Avian assemblages on altered grasslands. Studies in Avian Biology 15:247-257.

During last 25 years, grassland bird species have shown steeper, more consistent, and geographically widespread declines than any other behavioral or ecological guild of North American birds. Unlike forest species that winter in the Neotropics, birds that breed in North American grasslands also winter on the continent. Thus, problems driving declines in grassland species are associated almost entirely with North American processes, especially loss and degradation of North American grasslands.

Knopf, F. L., and F. B. Samson. 1992. Conserving the biotic integrity of the Great Plains. Pages 121-133 *in* S. R. Johnson and A. Bouzaher, editors. Conservation of Great Plains ecosystems: Current science, future options. Kluwer Academic Press, Dordrecht, The Netherlands.

Despite the relatively simplistic composition of the endemic avifauna in the Great Pains, endemic species are currently showing steeper, more consistent, and geographically widespread declines than any other group of North American birds. For example, 10 of 32 grassland bird species have declined at statistically significant rates from 1966 to 1991. Processes that shaped endemic plant and animals on the Great Plains were drought, grazing, and wildfire. These factors favored broad expanses of monotypic vegetation with minimization of ecological edges. Activities that have had universal effects on native diversity include fragmentation of grasslands, drainage of wetlands, invasion or introductions of alien and exotic species, and construction of water development activities. Impoundment of rivers and elimination of natural fire regimes has had severe consequences to native flora and fauna of the western Great Plains. Ninety percent of bird species presently breeding in northeastern Colorado did not breed there at the turn of the century.

Knopf, F. L., and M. L. Scott. 1992. Altered flows and created landscapes in the Platte River headwaters, 1840-1990. Pages 70-74 *in* J. M. Sweeney, editor. Management of dynamic ecosystems. The Wildlife Society, North Central Section, West Lafayette, Indiana.

Impoundment has severely reduced annual runoff peaks and total discharge in the Platte River. The Platte's deciduous gallery forest provides local habitats for more wildlife species than occurred historically in the headwaters. Unique characteristics of riparian ecosystems are the pulsed flow resulting from spring runoff and linear connectivity across elevational gradients. Stabilization of hydrodynamic regimes in headwater streams has drastically altered the characteristic fluvial processes that shaped these ecosystems. Annual floods with high sediment loads tended to maintain wide, shallow, and active river channels. Changes in hydrology can be attributed to removal of beaver, changes in upland land uses, and water developments for agriculture, municipal, and industrial uses. Woody vegetation on pristine rivers consisted of widely scattered stands of cottonwood and willows. Hydrologic conditions controlled the patterns of establishment and growth of woody riparian species. Increased summer flows have been the driving ecological force in Platte River and have enabled dramatic movements of faunal assemblages at the local and regional level. Connectivity provided by the riparian corridor has allowed western expansion of species such as white-tailed deer, fox squirrel, and numerous birds and small mammals.

Koford, R. R. 1999. Density and fledgling success of grassland birds in Conservation Reserve Program fields in North Dakota and west-central Minnesota. Studies in Avian Biology 19:187-195.

CRP fields were suitable breeding habitat for several species whose populations declined prior to program. Habitat furnished appeared to be as secure as other suitable habitats in federal Waterfowl Production Areas within these states. Additional cover provided by CRP may have lowered breeding densities in all habitats with possible benefits if reproduction was density dependent. Additional habitat also may have allowed some birds (e.g., second-year birds) to breed that otherwise would not have bred, thereby supporting higher growth of populations.

Koford, R. R., and L. B. Best. 1996. Management of agricultural landscapes for the conservation of Neotropical migratory birds. Pages 86-88 *in* F. R. Thompson III, editor. Management of midwestern landscapes for the conservation of Neotropical migratory birds. U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station, General Technical Report NC-781.

Thirty-eight Neotropical migratory birds are common in Midwest agricultural landscapes. Most of these species depend on herbaceous or wooded habitats that have declined as average size of farms has increased. Immediate effect of tillage is exposure of arthropods and other prey to foraging birds; long-term effect is reduction in abundance of litter-dwelling arthropods. Conventionally tilled fields had lower arthropod abundance than no-till or idle areas. Herbicides affected birds by reducing availability of seeds. Insecticides reduced abundance and diversity of foliage-dwelling arthropods. Strip cover, such as grassed waterways, terraces, fencerows, roadsides, and windbreaks/shelterbelts, usually provide stable habitat. Strip cover has decreased in recent years. Bird use of grassed waterways was influenced by orientation of buffer relative to crop rows: nest densities were greater when rows were parallel to waterways. Authors provided numerous recommendations for management of habitats for birds in agricultural landscapes.

Kramer, C. S., B. J. Elliott, L. M. Rubey, and G. E. Rossmiller. 1989. The political economy of U.S. agriculture: Challenges for the 1990s. Pages 267-281 *in* C. S. Kramer, editor. The political economy of U.S. agriculture: Challenges for the 1990s. National Center for Food and Agricultural Policy, Resources for the Future. Washington, D.C.

Krapu, G. A., P. J. Pietz, D. A. Brandt, and R. R. Cox. 2000. Factors limiting mallard brood survival in prairie pothole landscapes. Journal of Wildlife Management 64:553-561.

Evaluation of the effects of percent of seasonal basins holding water, percent of upland landscape in perennial cover, rainfall, daily minimum ambient temperature, hatch date, brood age, age of brood females, and brood size on mallard brood survival in prairie pothole landscape. Final fitted model contained only main effects of percent of seasonal basins holding water, rainfall, and hatch date. Authors recommended maintenance of seasonal wetlands as major component of wetland complexes and management for enhanced success of early laid clutches.

Kurzejeski, E. W. 1996. Vegetation structure and avian species composition in diverted farmland. Missouri Department of Conservation, Federal Aid Project No. W-31-R-05, Final Report. 75 pp.

Comparison of vegetative conditions, avian abundance, composition, and productivity on CP1, CP2, and rowcrop fields in northern Missouri. Total bird abundance, grassland bird abundance, nest density, and number of nesting species were lower on croplands than on CRP fields. Bird community using crop fields differed from that of CRP fields with shortgrass and open-ground feeding birds most common on crop fields. The conservation value of CRP fields for declining grassland bird species was higher for CP1 fields than CP2 fields. To increase the potential wildlife benefits of CRP and other idle grassland habitats, monotypic stands of either warm-season or cool-season grasses should be avoided. Because litter buildup and accelerated grass succession may negatively affect wildlife values of fields, authors recommended periodic haying and grazing of diverted farmlands. They also recommended that cost sharing of grass plantings should be limited to multi-species seedings.

Kurzejeski, E. W., L. W. Burger, Jr., M. J. Monson, and R. Lenkner. 1992. Wildlife conservation attitudes and land use intentions of Conservation Reserve Program participants in Missouri. Wildlife Society Bulletin 20:253-259.

Survey of CRP participants in Missouri to determine their attitudes toward wildlife conservation and intended uses of CRP lands. Sixty-two percent of respondents indicated wildlife was an important consideration in choice of farming practices. Only 9.4% of all respondents enrolled land in permanent wildlife habitat. Fifty-six percent of respondents indicated that they were unaware of this practice. Authors recommended increased educational efforts to promote wildlife management options should target both landowners and administering agencies.

Lambert, J. D., and S. J. Hannon. 2000. Short-term effects of timber harvest on abundance, territory characteristics, and pairing success of ovenbirds in riparian buffer strips. Auk 117:687-698.

Study compared abundance, territory characteristics, and pairing success of area-sensitive songbirds in 20, 100, and 200 m riparian buffer strips in boreal mixed-wood forest in Alberta. Ovenbirds were absent from 20 m buffers. Abundance and territory size were unaffected by harvest. Females were attracted by males in both buffer widths. Authors concluded that 100 and 200 m buffers retained ovenbirds during year following harvest but that long-term monitoring of harvest effects was needed.

Langer, L. L. 1989. Land use changes and hunter participation: The case of the Conservation Reserve Program. Transactions of the North American Wildlife and Natural Resources Conference 54:382-390.

Paper provided general review of Farm Bill effects on agricultural land use and wildlife habitat by region. Author provided regional estimates additional income derived from hunting on CRP lands. Overall value of hunting benefits from CRP between 1986 and 2000 was estimated to be $3.8 billion.

Lauber, B. 1991. Birds and the Conservation Reserve Program: A retrospective study. M.S. thesis. University of Maine, Orono. 252 pp.

Analysis of county-level estimates of bird population density data obtained from Breeding Bird Survey and land use statistics. CRP appeared to provide benefits for selected populations of avian species. Thirty-one of 102 species tested were correlated with CRP distribution. Four species (western meadowlark, ring-necked pheasant, brown-headed cowbird, northern bobwhite) showed evidence of positive population responses to CRP establishment. Study was completed during early years of CRP (1986-1988) when enrollment was relatively low and vegetative characteristics reflected early composition and structure of CRP plantings.

Leddy, K. L., K. F. Higgens, and D. E. Naugle. 1999. Effects of wind turbines on upland nesting birds in Conservation Reserve Program grasslands. Wilson Bulletin 111:100-104.

CRP grasslands without turbines and areas located 180 m from turbines supported densities of grassland birds four-times higher than areas within 80 m of turbines. Authors recommended that turbines be placed in cropland that support lower densities of grassland passerines than those found in CRP grasslands. Human disturbance, noise, and physical movements of turbines may have disturbed nesting birds.

Lee, C. D. 1995. Wildlife needs of the southern Great Plains for the 1995 Farm Bill discussions. Transactions of the North American Wildlife and Natural Resources Conference 60:315-319.

General description of benefits of Farm Bill to wildlife in the region and projected effects on wildlife if program was not reauthorized. Strategies outlined for following Farm Bill provisions: Conservation Compliance, CRP, Water Quality Improvement Program, Stewardship Incentive/Forest Incentive Programs, WRP and Water Bank, Agricultural Conservation Programs and Great Plains Contracts, Acreage Conservation Reserve, Total Farm Management Program, Riparian Corridor Program, and Wildlife Conservation Reserve Programs. Social benefits of Farm Bill program were identified.

Lewis, T. 1969. The diversity of insect fauna in a hedgerow and neighboring fields. Journal of Applied Ecology 6:453-458.

Hedgerows contributed to enriched insect fauna in neighboring fields. In terrestrial insect communities, diversity was greatest in hedges, lower in beans, and least in pasture. Diversity of aerial insects decreased with increasing distance from the hedge. Presence of hedge enriched aerial insect population for a distance of 10-times hedge height on the downwind side to one- to two-times hedge height on the upwind side.

Lichtenberg, E., and R. Zimmerman. 1999. Information and farmers' attitudes about pesticides, water quality, and related environmental effects. Agriculture, Ecosystems and Environment 73:227-236.

The effect of agricultural activities on environmental quality depends upon the behavior of farm operators. Farmers' beliefs are similar to those of the general public on average, but may be more polarized on environmental issues. Relationship between information and farmers' beliefs about environmental quality and compliance with environmental protection measures is complex. Effects of information depend both on the form in which the information is presented and on farmers' attitudes toward the sources presenting the information. Beliefs can influence the kind of information selected, receptivity, and how relevant farmers consider the information in affecting decision-making. Farm magazines are a frequent source of information followed by NRCS and extension agents. Extension services and institutional sources of information rank high in credibility.

Little, T., and R. A. Hill. 1993. CRP having an impact. Iowa Conservationist Sept./Oct.:4-9.

Description of agricultural and settlement impacts on wildlife habitats in Iowa. General description of CRP benefits to wildlife. Authors indicated that converting as little as 4% of county from rowcrops to CRP increased pheasant numbers seen on survey routes. Higher numbers of pheasants attributed to greater overwinter survival due to CRP. They reported > 15 nests of nongame birds per 40 acres of CRP compared to less than one nest in same area of rowcrops. Nest success of birds in CRP was 33% compared to 20% in hayfields. Waterfowl nest success in CRP as good or better than that observed in wildlife management areas.

Liverman, M., and T. Hemker. 1995. Agriculture/wildlife relationships in the western region. Transactions of the North American Wildlife and Natural Resources Conference 60:320-326.

Authors emphasized the importance of agricultural habitats for fish and wildlife in western region. Habitat needs and Farm Bill recommendations were provided for rangelands, croplands, aquatic habitats, species of special status, and woodlands.

Lokemoen, J. T., and J. A. Beiser. 1979. Bird use and nesting in conventional, minimum-tillage, and organic cropland. Journal of Wildlife Management 61:644-655.

Seasonal use by birds and nesting was evaluated in fallow, sunflower, and wheat fields among conventional farms, minimum tillage farms, reduced tillage, and organic farms (no synthetic pesticides). Spring bird densities were highest in minimum-tillage, fallow fields that provided food and cover. No differences in bird densities among crops of various field types in fall or winter, but mean densities in summer were highest in fallow fields. Fallow fields also had greater mean number of nesting species. Elevated densities of birds and nests in fallow fields were attributed to increased amounts of plant litter cover. Mean number of nesting species and nest densities were higher in minimum tillage and organic fields. Overall hatching success was low for waterfowl and shorebirds; nest success was also low for passerines. Nest losses were due to predation and farming activities. Hatch success was higher in minimum tillage fields for passerines and wheat fields for shorebirds. Nest densities in CRP were six-times greater than that found in minimum tillage stubble and organic fallow and 11-times larger than densities in other field types and crops.

Luttschwager, K. A. 1991. Effects of two haying provisions on duck nesting in Conservation Reserve Program (CRP) fields in South Dakota. M.S. thesis. South Dakota State University, Brookings. 51 pp.

Evaluation of the effects of two emergency haying provisions on duck nesting in CRP fields in South Dakota in 1988 and 1989. Nest densities in idle (nonhayed) strips and nonhayed fields were significantly greater than in hayed strips. Nest densities in idle and hayed blocks were similar. Nest success was lowest in idle strips that apparently attracted predators as well as ducks. Author recommended leaving a minimum of 25% of CRP fields in undisturbed block rather than in strips.

Luttschwager, K. A., and K. F. Higgins. 1991. Some sociological and ecological effects of the Conservation Reserve Program in the northern Great Plains. Pages 58-62 *in* L. A. Joyce, J. E. Mitchell and M. D. Skold, editors. The Conservation Reserve - yesterday, today, and tomorrow. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-203. 64 pp.

General treatment of benefits of CRP for improved air and water quality, provision of wildlife habitat, and reduction of soil erosion. Authors concluded that economic benefits were equivocal, raising net farm income, but reducing local economies. See also Luttschwager et al. (1994) regarding effects of emergency haying on nesting birds.

Luttschwager, K. A., and K. F. Higgins. 1992. Nongame bird, game bird, and deer use of Conservation Reserve Program fields in eastern South Dakota. Proceedings of the South Dakota Academy of Science 71:31-36.

Luttschwager, K. A., K. F. Higgins, and J. A. Jenks. 1994. Effects of emergency haying on duck nesting in Conservation Reserve Program fields, South Dakota. Wildlife Society Bulletin 22:403-408.

Study of duck nest densities and nest success among hayed and idled strips, blocks of planted grass, and idled CRP fields. Study was conducted in 1989 and 1990 in fields established in 1986 or 1987. Nest density in idle strips, blocks, and fields was 4-times greater than densities in hayed strips of blocks. Nest density in idled strips and fields higher than hayed strips, but success was reduced in [narrow] idled strips compared to [wide] hayed strips and idled fields. In 1990, hayed blocks had higher density of successful nests than strip cover. Authors concluded that annual haying was always undesirable for nesting waterfowl, but periodic mowing may be beneficial if performed in blocks (vs. strips) after July 20.

Lysne, L. A. 1991. Small mammal demographics in North Dakota Conservation Reserve Program plantings. M.S. thesis. University of North Dakota, Grand Forks. 48 pp.

Study conducted in North Dakota in summers of 1989 and 1990 examined small mammal demographics and population dynamics in four age classes of CRP plantings. Small mammal diversity on CRP tracts less than four years old was low. Eight species were detected with deer mice comprising 92% of all small mammals recorded. Density of deer mice changed seasonally and differed between years. Home range size and abundance similar for males and females. Author speculated that small mammal diversity and density of meadow voles would increase as CRP fields matured and litter accumulated. Author discussed potential effects of disturbances on small mammal community in CRP fields.

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

Report of males feeding nestlings in CRP fields in east-central Illinois. Annual variation in male provisioning attributed to differences in food abundance between years.

Major, R. E., F. J. Christie, G. Gowing, and T. J. Ivison. 1999. Elevated rates of predation on artificial nests in linear strips of habitat. Journal of Field Ornithology 70:351-364.

Comparison of nest predation rates and identity of nest predators between linear remnants and large remnants of woodland in Wheatbelt of Australia. Incidence of predation on artificial nests and number of predator species was greater in linear than in large remnants. Authors conclude that linear strips have limited value as breeding habitat.

Mankin, P. C. 1993. Agricultural land use and the eastern cottontail in Illinois. Ph.D. dissertation. University of Illinois, Urbana-Champaign. 94 pp.

Mankin, P. C., and R. E. Warner. 1999. Responses of eastern cottontails to intensive rowcrop farming. Journal of Mammalogy 80:940-949.

Study evaluated responses of eastern cottontails to intensive rowcrop farming in Illinois. Home ranges of cottontails averaged 2.3-times larger during growing season that in nongrowing season. During nongrowing season, homesteads were major component of home ranges. Homesteads made up < 2% of the study area but comprised 23% of home ranges and 40% of rabbit locations. Declines in rabbit numbers have been most pronounced in intensively farmed regions where rowcrop agriculture has replaced pasture, other early successional perennial vegetation, forage crops, and small grains. Loss of cottontail habitat in Midwest also attributed to greater use of herbicides and intensive fall tillage.

Margheim, G. A. 1994. Soil erosion and sediment control. Pages 15-18 *in* When Conservation Reserve Program contracts expire: The policy options. Soil and Water Conservation Society, Ankeny, Iowa.

Annual reduction in soil erosion attributed to the CRP was estimated at almost 700 million tons. If savings associated with lower commodity price support payments are considered with the productivity gains and environmental benefits, the total benefits of CRP exceed the program's costs. The author recommended targeting only the most highly erodible lands for CRP. This could provide an additional five to 10 percent reduction in soil erosion.

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.

Grassland bird species richness was higher on structurally diverse CP1 fields than on CP2 fields. Vegetation in CP2 fields was tall, dense monotypic stands of warm-season grass (switchgrass). In areas where grass monocultures exist, disturbances to decrease the height and density of vegetation and increase plant diversity may be beneficial for grassland birds. Provisions for periodic haying and grazing may enhance habitat value.

McCoy, T. D., M. R. Ryan, E. W. Kurzejeski, and L. W. Burger. 1999. Conservation Reserve Program: Source or sink habitat for grassland birds in Missouri. Journal of Wildlife Management 63:530-538.

Study estimated fecundity of seven grassland bird species nesting in CRP fields in northern Missouri. They compared their results with estimates of fecundity necessary to maintain stable populations. Results varied by species and year. Authors concluded that CRP contributed to conservation of grasshopper sparrows, field sparrows, and eastern meadowlarks; they found little evidence that CRP was beneficial for dickcissels or red-winged blackbirds.

McKean, J. R., and R. L. Johnson. 1993. Can increased migratory bird hunting offset negative economic impacts of the CRP in northeast Colorado? Colorado State University Experiment Bulletin. Fort Collins.

McKean, J. R., E. Ekstrand, and R. L. Johnson. 1994. Recreational fishing offsets to the negative economic impacts of the CRP in Wisconsin. Colorado State University Experiment Bulletin. Fort Collins.

McKinnon, D. T., and D. C. Duncan. 1999. Effectiveness of dense nesting cover for increasing duck production in Saskatchewan. Journal of Wildlife Management 63:382-389.

Comparison of nesting success and nest density of mallards, gadwalls, northern shovelers, and blue-winged teal in unmanaged plots (UM) and plots with dense nesting cover (DNC) in Saskatchewan prairie-parkland. Nesting success for all species combined was greater in DNC than in UM, but varied by species, treatment, and plots. Conversion of cropland to pasture was recommended as cost-effective strategy for increasing duck numbers.

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. MS thesis. Michigan State University, East Lansing.

Avian communities and vegetative characteristics were examined in six age-class fields (one to six growing seasons) in central Michigan to determine relations between field age and characteristics of avian communities. Results suggested a relationship between age of CRP fields and avian abundance, diversity, and productivity. Younger CRP fields that were characterized by forbs and bare ground supported greater densities and diversities of birds than older fields. Older fields with greater litter cover and grass cover supported the greatest productivity. Few significant differences were found among field age-classes but mean insect diversities and biomass generally decreased as CRP fields aged. Seventy percent of surveyed landowners considered improvement of wildlife habitat in their decision to enroll into CRP. Author concluded that grassland birds may require a diversity of age classes of CRP fields in agricultural landscapes to meet habitat requirements. She recommended controlled disturbance in years four through six.

Millenbah, K. F., S. R. Winterstein, H. Campa III, L. T. Furrow, and R. B. Minnus. 1996. Effects of Conservation Reserve Program field age on avian relative abundance, diversity, and productivity. Wilson Bulletin 108:760-770.

Study conducted in Michigan in 1992 examined effects of age of CRP fields on avian relative abundance, diversity, and productivity. CRP fields dominated by introduced grasses and legumes had greatest avian diversity and abundance at one to two years old; avian productivity was greatest in older fields (three to five/six years of age) with several grass species and deep litter. Authors recommended that CRP fields be periodically disturbed to provide a variety of successional stages.

Miller, E. J. 1989. Wildlife management on Virginia Conservation Reserve Program land: The farmers' view. M.S. thesis. Virginia Polytechnic Institute and State University, Blacksburg. 91 pp.

Seventy-two percent of respondents indicated that they wanted to improve wildlife habitat on retired land. Most respondents indicated that they had not been informed about improving habitat on CRP land. USDA personnel were primary source of habitat information for program participants. Only 5% of land was planted to permanent wildlife habitat. Mowing of entire CRP acreage was primary means of weed control. Leasing of CRP land to hunters was uncommon. Results indicated a high level of interest in wildlife and need for getting more detailed information to landowners from USDA and wildlife agencies.

Miller, E. J., and P. T. Bromley. 1989. Wildlife management on Conservation Reserve Program land: The farmers' view. Transactions of the North American Wildlife and Natural Resources Conference 54:377-381.

Survey of CRP participants in Iowa and Virginia indicated that most were interested in improving CRP fields for wildlife. Lack of specific information and education about how to improve lands for wildlife appeared to be an important limitation. Objection to regulations and "red tape" may have further constrained adoption of habitat improvement programs. Improvements in wildlife habitat on CRP lands will require aggressive outreach by wildlife agency staff (rather than USDA county staff) who can furnish precise information for improvement in habitat for wildlife.

Miller, E. J., and P. T. Bromley. 1989. Wildlife management on Conservation Reserve Program land: The farmers' view. Journal of Soil and Water Conservation 44:438-440.

Results from a survey of Iowa and Virginia farmers regarding their interest in improving wildlife habitat, adequacy of available information on wildlife habitat options, current management of retired land, and financial incentives required to implement a wildlife plan. Constraints to implementing wildlife measures included lack of information, negative attitudes toward hunters, high costs of wildlife covers, and physical limitations of CRP participants. Authors recommended aggressive distribution of information and education efforts by wildlife and extension agencies.

Miller, M. S., D. J. Buford, and R. S. Lutz. 1992. Habitat use, productivity, and survival of Rio Grande wild turkey hens in southwestern Kansas. Page 27 *in* 1991 Noxious brush and weed control: Range and wildlife management. Texas Tech University, Lubbock.

Miller, M. W. 2000. Modeling annual mallard production in the prairie-parkland region. Journal of Wildlife Management 64:561-575.

Evaluation of the effect of precipitation, cold spring temperatures, wetland abundance, and upland breeding habitat on mallard production in the prairie-parkland region of the United States and Canada. May-June pond numbers and size of breeding population best predicted mallard production at continental scale. Variables that best modeled production at stratum scale differed by region.

Mills, R. C. 1993. CRP grassland and wildlife management. U.S. Department of Agriculture, Soil Conservation Service. Missouri Bulletin No. MO300-3-1. 9 pp.

Minnesota Extension Service. 1993. The CRP in the Midwest: What should we do next? University of Minnesota, St. Paul. 16 pp.

Miranowski, J. A., and R. L. Bender. 1982. Impact of erosion control policies on wildlife habitat on private lands. Journal of Soil and Water Conservation 37: 288-291.

Analysis of relation between upland wildlife habitat quality and erosion control policies for protection of soil productivity and improvement of water quality. Authors concluded that (1) policies designed to reduce soil erosion tended to improve upland habitat quality and water quality; (2) some policies were more effective than others at improving habitat; and (3) policies that encouraged changes in land use had greater effect on habitat quality than did changes in tillage systems.

Moulton, R. J. 1994. Sorting through cost-share assistance programs. Tree Farmer. November/December 1994.

Moulton, R. J., B. Baldwin, and J. Snellgrove. 1991. Impacts of Conservation Reserve Program tree planting on biological diversity. Southern Forest Economist, Feb. 20-22, 1991. Washington, D.C.

Sample of CRP plantations in Southeast showed that most were comparatively small and over 70% were freestanding (i.e., not adjoined by existing pine stands) and none were encompassed within pine stands. Over 2.2 million acres of trees have been planted under CRP, mostly in southeastern states. Trees represented > 90% of CRP in Florida and Georgia, 79% in South Carolina, and > 50% in Alabama, Arkansas, Louisiana, Mississippi, and North Carolina. Ninety-seven percent of tree plantings were softwoods (loblolly and slash pine). CRP pine replaced cropland in 80% of cases.

National Audubon Society. 1994. Investing in wildlife, multiple benefits for agriculture and the American people. Washington, D.C. 27 pp.

National Audubon Society. 1995. Investing in wildlife, multiple benefits for agriculture and the American people. Washington, D.C. 16 pp.

This brochure was prepared by the National Audubon Society to describe the benefits of certain agricultural practices to wildlife in support of the development of the 1996 Farm Bill. The wildlife benefits of the first 10-year CRP contracts were described. Other USDA programs described include: Water Bank, Water Quality Incentives Program, Agriculture Conservation Program, Wetlands Reserve Program, and debt restructure through the Farmers Home Administration. The article concludes with the Society's recommendations for changes in the 1995 Farm Bill.

National Research Council. 1982. Impacts of emerging agricultural trends on fish and wildlife habitat. National Academy Press. 244 pp.

Newtow, J. A., and J. S. Beck. 1993. Conservation Reserve Program fish and wildlife benefits. State of Oregon report to local Soil and Water Conservation Districts. Oregon Department of Fish and Wildlife, Salem.

Niemuth, N. D. 2000. Land use and vegetation associated with greater prairie-chicken leks in an agricultural landscape. Journal of Wildlife Management 64:278-286.

Comparison of land use around greater prairie chicken leks and random points in a central Wisconsin agricultural landscape. Areas around leks had greater proportions of grasslands, wetlands, and shrubs, and lower proportions of forests, rowcrops, and hayfields than areas around random points. Differences between leks and random points and correlates of number of males varied with scale of sampling.

Nowak, P. J., M. Schnepf, and R. Barnes. 1990. A national survey of farm owners and operators who have enrolled land in the Conservation Reserve. Soil and Water Conservation Society. Ankeny, Iowa.

O'Connell, M. A., and R. F. Noss. 1992. Private land management for biodiversity conservation. Environmental Management 16:435-450.

For the purpose of conservation, ecosystem diversity must be defined on basis of geographically recognizable units representing commonly associated flora and fauna. Species profiting from habitat diversification are generally least in need of conservation efforts (e.g, species associated with diversification in cover types). Managers have customarily enhanced local species diversity by maintaining numerous edges between habitat types; however, this practice usually is detrimental for endemic species. Maintenance of diversity from regional and global perspective actually permits more flexibility in land use options than a strategy that considers sites in isolation. For example, loss of a species from a specific site may not have detrimental effects for biodiversity if the species is regionally or globally abundant. Regional biodiversity management does not preclude habitat manipulation to favor certain species; however, standards for private land management consistent with goal of conserving biodiversity are not simple to delineate. Paper provided specific steps and guidelines for identification of biodiversity priorities on private lands.

O'Connor, R. J., and M. Shrubb. 1986. Farming and birds. Cambridge University Press, Great Britain. 290 pp.

Ogg, C. W., M. P. Aillery, and M. O. Ribaudo. 1989. Implementing the Conservation Reserve Program: Analysis of environmental options. U.S. Department of Agriculture, Forest Service, Economic Research Service, Agriculture Economic Report 618. Washington, D.C. 26 pp.

Osborn, C. T., F. Llacuna, and M. Linsenbigler. 1992. The Conservation Reserve Program, enrollment statistics for sign-up periods 1-11 and fiscal years 1990-92. U.S. Department of Agriculture, Economic Research Service, Statistical Bulletin Number 843. Washington, D.C. 86 pp.

Osborn, C. T., F. Llacuna, and M. Linsenbigler. 1995. The Conservation Reserve Program, enrollment statistics for sign-up periods 1-12 and fiscal years 1990-93. Department of Agriculture Economic Research Service, Statistical Bulletin Number 843. Washington, D.C. 102 pp.

Report presented tables for all CRP cropland enrolled in sign-ups 1-12 and CRP cropland newly retired between 1986 and 1993.

Osborn, C. T., M. Schempf, and R. Keim. 1995. The future use of Conservation Reserve Program acres: A national survey of farm owners and operators. Soil and Water Conservation Society, Ankeny, Iowa. 47 pp.

Owens, R. A., and M. T. Myres. 1973. Effects of agriculture upon populations of native passerine birds of an Alberta fescue grassland. Canadian Journal of Zoology 51:697-713.

Disturbance of fescue grasslands by haying or grazing reduced or eliminated Baird's sparrow and Sprague's pipit, but permitted ingress of horned lark and chestnut-collared longspur. Removal of native grasslands by plowing and cultivation for cereal crops eliminated all passerine species except the horned lark. Vegetation physiognomy probably influenced the distribution of grassland passerine species. Prairie passerines that evolved to exploit original grassland environments were forced use of various habitats created by agriculture. Species that required dense grass were largely eliminated by heavy grazing. Varying grazing intensities will produce changes in vegetative structure and composition of grassland bird community. Under light to moderate grazing, the full range of prairie passerines may occur. Under heavier than normal grazing, species that favor shortgrass will predominate. Some species will be present under any condition (meadowlarks). Native passerines are adapted to habitats that were grazed by ungulates and subject to periodic fires. Therefore, areas managed to preserve grasslands and native avifaunas should allow these factors to operate to create similar conditions.

Pajak, P. 1991. Fisheries implications of the 1990 Farm Bill. Fisheries 16:4.

Pajak, P., and J. Bauman. 1992. Fisheries resources: Opportunities for enhancement through the Conservation Title. The social, economic, and environmental consequences of the conservation components of the Food Security Act of 1985. Soil and Water Conservation Society Symposium, March 1-2, 1989. Columbus, Ohio.

Patterson, M., and L. B. Best. 1993. Avian abundance and productivity on Conservation Reserve Program lands in central Iowa (abstract only). Proceedings of the Midwest Fish and Wildlife Conference 55:171.

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

Although many bird species frequented rowcrop fields, abundance was relatively low and few species nested there. Because of predation, parasitism, and farming activities, bird reproduction in rowcrops may be below levels needed to sustain populations. CRP likely has contributed to an increase in the abundance of many bird species in central Iowa, because it replaced rowcrop with permanent grass cover. CRP fields were better nesting habitat for grassland birds than roadsides, grassed waterways, and other covers associated with Iowa agriculture. Differences in nesting success between habitats were attributed to diverse vegetation structure and composition, large block nature, and reduced agricultural activity in CRP. Authors recommended (1) selection of CRP plantings that provide diverse structure and composition favored by grassland birds; (2) deferral of mowing and spraying of CRP fields for weed control until after July; and (3) maintenance of whole field enrollments. They indicated that the effects of disturbances (disking, burning, grazing, and interseeding) needed further evaluation.

Pearks, A. J. 1995. The effects of habitat manipulation on vegetation characteristics and avian communities on Conservation Reserve Program fields in Gratiot County, Michigan. M.S. thesis. Michigan State University, East Lansing.

Pimental, D. U. Stachow, D. A. Takacs, H. W. Brubaker, A. R. Dumas, J. J. Meaney. J. A. S. O'Neil, D. E. Onsi, and D. B. Corzilius. 1992. Conserving biological diversity in agricultural/forestry systems. BioScience 42:354-362.

Authors argued that because agriculture, forestry, and human settlements occupy up to 95% of terrestrial environment, a large portion of world's biodiversity coexists within these ecosystems. Paper provided general treatment of concept of biological diversity (e.g., definitions, abundance, biomass, and diversity of organisms in relation to their size and phylogeny) and discussed implications of specific agricultural practices for biological diversity. Authors maintained that biological diversity in agricultural/forestry systems can best be conserved by (1) sustaining abundant biomass/energy and plant and habitat diversity; (2) conserving soil, water, and biomass resources; and (3) reducing the use of pesticides and similar toxic chemicals.

Price, M. 1991. Family farming in Minnesota. Soil and Water Conservation News 12:12-13.

The author described CRP activities in Minnesota. He also noted the U.S. Fish and Wildlife Service role in wetland restoration on CRP lands. Landowner quotes and photographs were provided to illustrate wildlife, soil, and water quality benefits of CRP.

Reichelderfer, K. 1990. Environmental protection and agricultural support: Are trade-offs necessary? Pages 201-230 *in* K. Allen, editor. Agricultural policies in a new decade. Resources for the Future and National Planning Association. Washington, D.C.

Author suggested that traditional means of supporting farm income tended to exacerbate environmental problems. Under current programs, agricultural and environmental protection reflect conflicting societal preferences. Public reaction to environmental problems suggests that nonfarm population believes that their right to a clean, safe, and healthy environment may be infringed upon by farming activity. Long-term environmental goals of American public conflict with the short-run profit objectives of individual farmers. Adoption of new technologies requires capital investment, increased operating costs, or some forfeiture of yield, any of which can reduce farm income in the short run. Efforts, therefore, must focus on increasing the cost-effectiveness of environmentally friendly technologies and higher levels of funding to meet policy objectives. Farm Bill has provided some consistency between environmental and agricultural policy objectives, but it could be improved.

Renner, R. W., R. E. Reynolds, and B. D. J. Batt. 1995. The impact of haying Conservation Reserve Program lands on productivity of ducks nesting in the Prairie Pothole Region of North and South Dakota. Transactions of the North American Wildlife and Natural Resources Conference 60:221-229.

Comparison of nest success and duck production in hayed versus nonhayed portions of CRP fields. Production was higher on nonhayed portions. Authors suggested that changes in litter depth and vegetation structure caused by haying might adversely impact nesting through entire year following haying. They recommended haying no more than once every five years to maintain vegetation quality and habitat diversity.

Renner, R. W., R. E. Reynolds, and B. D. J. Batt. 1995. The impact of haying Conservation Reserve Program lands on productivity on ducks nesting in the Prairie Pothole Region of North and South Dakota. Unpublished Report. 25 pp.

In 1994, the authors conducted a one-year study of the impact of emergency haying of CRP fields to duck production in the Prairie Pothole Region of North and South Dakota. In 1993, 50 North Dakota and 47 South Dakota counties were opened to emergency haying from mid-August to late September. This investigation showed mean production of hatchlings was higher in undisturbed CRP fields than in hayed CRP fields. The mean daily survival rate of nests was not significantly different. Nest densities of all species combined were significantly higher in undisturbed fields. The authors recommended haying CRP no more than once every five years to maintain vegetation quality and habitat diversity.

Reynolds, R. 1992. Evaluation of the effect of CRP on duck recruitment in the Prairie Pothole Joint Venture Area of FWS, Regions 6. U.S. Fish and Wildlife Service Progress Report. Bismarck, North Dakota. 6 pp.

Report on results of 1992 pilot effort to evaluate waterfowl production in Montana, North Dakota, and South Dakota. Nest success was estimated to be about two- to three-times higher in CRP grasslands than in Waterfowl Production Areas.

Reynolds, R. 1994. Evaluation of the effect of CRP on duck recruitment in the Prairie Pothole Joint Venture Area of FWS, Region 6. 1994 Progress Report. U.S. Fish and Wildlife Service, Bismarck, North Dakota. 4 pp.

The objective of this four-year study was to evaluate the effect of the CRP on the recruitment of ducks in the Prairie Pothole Joint Venture Area of Montana, North Dakota, and South Dakota. This report summarized the first three years of findings. The study area covers approximately 2.9 million acres of CRP lands and in 1994, with excellent wetland conditions, an estimated 37 nests per 100 CRP acres were initiated over the entire study area. Nest success was estimated to be 18 to 30 percent, which was higher than considered necessary to maintain a stable duck population. Authors speculated that benefits of CRP extended beyond nesting cover and included increased brood survival. It was noted that large portions of CRP in the Dakotas were opened for emergency haying in 1993. Nest densities in the following year were lower on those fields that had been hayed in the previous summer. The author concluded this activity would have greater impact on early nesting species such as mallard and northern pintail.

Reynolds, R. E., D. R. Cohan, and M. A. Johnson. 1996. Using landscape information approaches to increase duck recruitment in the Prairie Pothole Regions. Transactions of the North American Wildlife and Natural Resources Conference 61:86-93.

Authors described procedure to prioritize areas for nesting duck management based on models developed from digital wetland data, data on duck pair/wetland relationships, and breeding duck home range characteristics. Procedure was applied to two North Dakota counties; the resulting map displayed the area as four priority levels based on their potential for breeding ducks. Utility of map was demonstrated by selecting example areas and prescribing specific treatments based on other landscape characteristics.

Reynolds, R. E., D. R. Cohan, and A. Kruse. 1994. Which cropland to retire: A waterfowl perspective. Pages 110-111 *in* When Conservation Reserve Program contracts expire: The policy options. Soil and Water Conservation Society, Ankeny, Iowa.

Authors used mallard population model to assess the impact of CRP acreage reductions on sample population of waterfowl in the Prairie Pothole Region of North Dakota.

Reynolds, R. E., T. L. Shaffer, R. W. Renner, W. E. Newton, and B. D. J. Batt. In review. Impact of the Conservation Reserve Program on duck recruitment in the U.S. Prairie Pothole Region. Journal of Wildlife Management. In review.

Authors estimated contribution of CRP to waterfowl recruitment in U.S. Prairie Pothole Region during 1992-1997. Survival of duck nests was positively related to proportion of perennial cover in study plots for four or five duck species and generally was higher during CRP period than during pre-CRP period in all habitat types. Compared to a simulated landscape in which CRP was replaced by cropland, estimated nest success was 50% higher and recruitment rates were 31% higher for five species combined in 1992-1997. It was estimated that CRP contributed an additional 10.5 million waterfowl to fall flight during 1992-1997.

Reynolds, R. E., T. L. Shaffer, J. R. Sauer, and B. G. Peterjohn. 1994. Conservation Reserve Program: Benefit for grassland birds in the northern Plains. Transactions of the North American Wildlife and Natural Resources Conference 59:328-336.

This study compared daily survival rates of duck nests in CRP fields to those found in other planted cover, and compared population trends for nonwaterfowl populations in the Prairie Pothole Region of North and South Dakota in 1992 and 1993. The authors concluded that CRP provided benefits for some grassland nesting birds. Nest success for mallard, gadwall, and blue-winged teal in CRP cover was two to nine percent higher than the threshold value needed for population maintenance. Nest success of ducks was similar in CRP sites and other sites with planted cover. Authors reported that some, but not all, grassland nesting birds had population increases since the establishment of the CRP. Factors other than breeding habitat availability may be influencing species that have not shown population increases.

Ribaudo, M. O. 1989. Water quality benefits from the Conservation Reserve Program. U.S. Economic Research Service, Agricultural Economic Report 606. Washington, D.C.

Ribic, C. A., R. E. Warner, and P. C. Mankin. 1998. Changes in upland wildlife habitat on farmland in Illinois 1920-1987. Environmental Management 22:303-313.

Authors developed an index to evaluate changes in agricultural ecosystems as they affected wildlife habitat. Indices at the county level had potential to be used in a multi-scale analysis to investigate the impact of policy changes on large-scale areas of the Midwest and to develop regional perspectives of the impacts of agriculture on upland wildlife and habitats.

Rietveld, W. J. 1993. When CRP contracts expire: Alternative strategies to encourage environmentally acceptable land use. Pages 89-96 *in* Proceedings of the Great Plains Agricultural Council. Annual meeting, June 2-4. Rapid City, South Dakota.

Riddle, M., M. D. Skold, and W. L. Trock. 1994. The future of the Conservation Reserve Program in Colorado. Colorado State University, Department of Agricultural and Resource Economics, Technical Report TR94-5. 41 pp.

Survey of CRP participants in Colorado to ascertain their expectations of CRP. Economic factors were the most important reason for program participation. Soil conservation also was an important consideration. If program expired, respondents indicated that about 38% of CRP land would be returned to production and a similar amount would remain in grass. Infrastructure to accommodate livestock generally not available on CRP grasslands. New fences and development of water resources would be needed to convert CRP grassland to grazing.

Riley, S. P. 1995. CRP: Icon of a new age. Transactions of the North American Wildlife and Natural Resources Conference 60:327-329.

Personal reflection of Farm Bill benefits for wildlife.

Riley, T. Z. 1992. Ring-necked pheasants and food plot size. Prairie Naturalist 24:185-189.

Study examined the relation of food plot size to winter use by pheasants in north-central Iowa in 1986 and 1988. Relationship differed between years and sexes, but was strongest in the coldest winter with greatest snowfall. Author recommended food plots ≥ 4 ha in size.

Riley, T. Z. 1993. Effects of CRP on ring-necked pheasants in Iowa (1985-91). Proceedings of the Midwest Fish and Wildlife Conference 55:172 (abstract only).

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

Pheasant numbers in Iowa increased 30% during first five years of CRP compared to a similar period before the program. Numbers increased 34% in counties with > 70% of cropland and 26% in counties with 50-70% cropland. Increases not detected in counties with < 50% in cropland. Pheasant numbers positively related to CRP but also influenced by percent cropland and cumulative snowfall. Positive association between pheasant survey counts and CRP land enrollment may have resulted from an increase in nesting and winter cover. Addition of idle grass-forb fields provided by program might have improved survival of females and enhanced reproductive success by increasing amount and dispersion of roosting and nesting cover.

Risley, D. L., D. P. Scott, and A. H. Berner. 1995. Midwest wildlife needs assessment for the 1995 Farm Bill - a need to focus efforts. Transactions of the North American Wildlife and Natural Resources Conference 60:281-287.

Authors provided history of land retirement programs, landscape changes, and decline in wildlife populations in midwestern states. Habitat goals for grassland-nesting, wetland-dependent, forest, and riparian/aquatic wildlife were provided. Farm Bill strategy was outlined.

Risley, D. L. et al. 1995. 1995 Farm Bill: Wildlife options in agricultural policy. Wildlife Society Technical Review 95-1. 24 pp.

This publication described the 1985 and 1990 Farm Bills and all the conservation programs and provisions including CRP, Swampbuster, Sodbuster, Conservation Compliance, Wetlands Reserve Program, Forest Stewardship Program, and Farmers Home Administration programs. It provided a summary of wildlife research conducted on CRP lands. Current implementation practices were described. The Wildlife Society's recommendations for the 1995 Farm Bill were provided.

Robinson, A. Y. 1991. Agriculture and wildlife in 2020. Pages 67-76 *in* T. J. Peterle, editor. 2020 Vision: Meeting the fish and wildlife conservation challenges of the twenty-first century. Midwest Fish and Wildlife Conference, December 3, 1991. Des Moines, Iowa.

Robinson, A. Y. 1988. Implementation of conservation compliance: Implications for soil, water, and wildlife. Transactions of the North American Wildlife and Natural Resources Conference 53:210-221.

Early review of legal, administrative, social, economic, and environmental aspects of conservation compliance provisions of 1985 Food Security Act.

Robinson, S. K., J. A. Grzybowski, S. I. Rothstein, M. C. Brittingham, L. J. Petit, and F. R. Thompson. 1993. Management implications of cowbird parasitism on Neotropical migrant songbirds. Pages 93-102 *in* D. M. Finch and P. W. Stangle, editors. Status and management of Neotropical migratory birds. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-229. 422 pp.

Human activities have contributed to increases in cowbird populations that now potentially threaten populations of many Neotropical migrant songbirds. Best preventative measure is to manage large areas on a landscape level. Bigger tracts are preferable to smaller ones and compact shapes (square) are better than complex shapes with high ratios of edge to interior. Acquisition should focus on inholdings to minimize fragmentation. Woody fencerows, snags, and corridors within and adjacent to prairie should be removed.

Robel, R. J., J. P. Hughes, S. D. Hull, K. E. Kemp, and D. S. Klute. 1998. Spring burning: Resulting avian abundance and nesting in Kansas CRP. Journal of Range Management 51:132-138.

Study evaluated the effects of spring burns (1992-1995) on vegetation structure and avian populations in southeastern Kansas CRP fields planted to native grasses. Spring burning reduced nest numbers in the summer of management action but did not reduce the number of nests found in those fields in following summers. Annual burning was considered to be too frequent to maximize avian habitat quality. Less frequent application of fire as a management tool was recommended.

Robel, R. J., and K. E. Kemp. 1997. Winter mortality of northern bobwhites: Effects of food plots and weather. Southwestern Naturalist 42:59-67.

Winter mortality rate was estimated for northern bobwhite quail in Kansas. Estimated mortality rates for bobwhites within 600 m of food plots ranged from 24-46% vs. 20-82% for bobwhites > 900 m from food plots. Number of days with > 10 cm snow cover and duration of < 5°C January temperatures were significantly correlated with and best predictors of mortality.

Robinson, R. A., L. L. Atkins, C. R. Kirby, P. A. Dommel, F. J. Schaefer Jr., and J. D. Hall. 1992. Conservation Reserve Program: Cost effectiveness is uncertain. Report to the Chairman, Subcommittee on Agriculture, Rural Development, Food and Drug Administration, and Related Agencies, Committee on Appropriations, House of Representatives. U.S. General Accounting Office. GAO/RCED-93-132. 14 pp.

Rodiek, J., and G. DelGiudice. 1994. Wildlife habitat conservation: Its relationship to biological diversity and landscape sustainability: A national symposium. Landscape Urban Planning 28:1-3.

Rodenhouse, N. L., and L. B. Best. 1983. Breeding ecology of vesper sparrows in corn and soybean fields. American Midland Naturalist 110:265-275.

Nesting success in corn and soybean fields was low. Nest losses were due primarily to agricultural operations and predation. Nest predation was higher near uncultivated edges because of increased predator activity. On cultivated land, nest predators use strip-cover as travel lanes, thus higher predation in or near these habitats should be expected. Breeding success would be greater if the number of tillage operations was reduced and crop residue was retained on the fields.

Rodenhouse, N. L., L. B. Best, R. J. O'Connor, and E. K. Bollinger. 1993. Effects of temperate agriculture on Neotropical migrant landbirds. Pages 280-295 *in* D. M. Finch and P. W. Stangle, editors. Status and management of Neotropical migratory birds. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-229. 422 pp.

Ecology of Neotropical migrant landbirds was reviewed for the purpose of developing management recommendations. Migrants constituted about 71% of bird species using farmland and 86% of bird species nesting there. Migrants' use of farmland was greatest in uncultivated edges with trees and shrubs; intermediate in uncultivated, grassed areas; and lowest in rowcrops. Increasing agricultural mechanization and chemical use have probably lowered the breeding productivity of migrants. Homogeneous, larger farms specializing in few commodities have created ecosystems that often lack suitable interspersion of required habitat resources. Practices that promote greater productivity include reduced tillage, inorganic fertilizer application, and use of integrated pest management.

Most migrants using temperate farmland were grassland or edge species. Agriculture was implicated in the decline of all nine Neotropical migrants currently listed (or candidate species) as threatened or endangered. How agriculture has contributed to this is unclear, but farmland structure and types of crops grown are probably major factors. The percentage of farmland in hay or pasture or in uncultivated semi-natural habitat was negatively correlated with area of intensively cultivated rowcrops.

Diversity and abundance of migrants were greater in wider strips of uncultivated edge vegetation. Uncultivated wooded areas included wooded fencerows or the edges of fields bordering woodland; grassed edge included some fencerows, waterways, terrace berms, road edges, and most land in the CRP. Breeding productivity of migrants in farmland was often below the threshold level needed for population maintenance. Percentage of county area in the CRP was positively associated with the abundance of 19 migrant species, 12 of which were grassland species.

Many migrants are wholly or partly insectivorous. Abundance of litter-dwelling arthropods was greater in fields where plant litter on soil surface was relatively dense. Herbicides and insecticides reduced food availability for birds. Areas in permanent cover, even if only grasses or no-till cropland, generally supported higher arthropod abundance than conventionally tilled fields. Arthropod abundance was greater near permanent vegetated field edges and greater in fields surrounded by complex habitats. Weed seeds were more abundant near uncultivated areas because of seed dispersal from uncultivated areas and because permanent vegetation concentrated wind-dispersed arthropods and seeds. Homogenization of farmland lowers diversity and abundances of plants, seeds, and arthropods within field and the landscape.

Presence of sheltering vegetation may be needed for some migrants, particularly edge species. Farmland complexity has declined in most agricultural regions because of increased use of large equipment, larger field size, crop specialization, and increased average size of farms. Absence of safe nesting sites may be limiting reproduction and survival of migrants in cropland. Agricultural land uses increased concentrations of nesting birds and predators. Authors also discussed the future of agriculture, provided management recommendations, and identified research needs.

Rodgers, R. D., and J. B. Wooley. 1983. Conservation tillage impacts on wildlife. Journal of Soil and Water Conservation 38:212-213.

Paper outlined potential benefits of conservation tillage for reducing or eliminating disturbance to nests in small grain and rowcrops. Authors also discussed consequences of conservation tillage for wildlife outside of the breeding season and rodent infestations.

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

Study of pheasant decline (65%) in western Kansas from 1966-75 to 1986-1995. CRP fields were preferred by pheasant broods, but pheasant use of CRP in winter was reduced compared to weedy wheat fields. Decline attributed to increased herbicide treatment of wheat fields, inadequate plant diversity, poor stand maintenance, and large size of CRP fields. Authors recommended (1) interseeding of perennial legumes and other forbs into recently burned CRP fields and (2) strip-disking fireguards around CRP fields to facilitate burning, stimulate growth of broad-leaved annuals, and increase edge. It was anticipated that interspersion of grass-legume strips on intensively farmed croplands through continuous CRP will improve pheasant habitat.

Roseberry, J. L., and L. M. David. 1992. The Conservation Reserve Program and northern bobwhite population trends in Illinois. Illinois Department of Conservation, Federal Aid in Wildlife Restoration Job Completion Report. Project W-106-R. 64 pp.

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.

Contributions of CRP to improvements in Illinois quail habitat were less than expected. CRP land positively contributed to local habitat quality, but in some situations, CRP may have neutral or negative effects. CRP land comprised a small proportion of total habitat base. CRP contribution to quail habitat could be improved if there was less midsummer mowing, more weedy vegetation as a consequence of strip disking and burning, and less planting of cool-season grasses.

Ryan, M. R. 1986. Nongame management in grassland and agricultural ecosystems. Pages 117-136 *in* J. B. Hale, L. B. Best and R. L. Clawson, editors. Management of nongame wildlife in the Midwest: A developing art. 74th Midwest Fish and Wildlife Conference. Chelsea, Michigan.

Acquisition, reclamation, and proper management of grassland resources must become a priority if we are to conserve the genetic diversity of native prairie flora and fauna. Grasslands contain substantial habitat diversity primarily in the horizontal plane. Author described grassland ecosystem as a mosaic of habitat types historically influenced by soil moisture and grazing intensity. Opportunities to manage prairie tracts of sufficient size to include all aspects of the prairie vegetation continuum are rare. They suggested that an alternative approach would be to manage smaller tracts as components of the overall prairie mosaic. Goal of nongame grassland management should be the conservation of wildlife species native to prairie habitats. Management actions must be defined on a state- or region-wide basis. If diversity of species indigenous to prairie ecosystems is objective, then the management plan must be developed on large scale and implemented through integrated management of local units.

Large blocks will contain more species than a small unit of similar habitats. However, there is controversy around the question of whether a large tract will maintain more species than several small tracts that combined are of equal size to the larger tract. Authors proposed the following ranking criteria for land acquisitions: (1) sites that regardless of size contain rare species or habitats that could support them; (2) large tracts that contain a mosaic of habitat types; (3) clusters of small tracts that provide or can be managed for a variety of components of the prairie mosaic; (4) large homogeneous blocks of grassland; and (5) small, highly isolated units of grassland.

Ryan, M. R., L. W. Burger, and E. W. Kurzejeski. 1998. The impact of CRP on avian wildlife: A review. Journal of Production Agriculture 11:61-66.

A review of grassland bird diversity, abundance, and reproductive success in CRP during breeding season in central United States. Over 90 species were documented using CRP planting during breeding season; > 40 species were recorded as nesting. Bird abundance in CRP was 1.4- to 10.5-times greater than in crop fields. Nest abundance was 8.8- to 27-times higher in CRP fields than in crop fields. Overall, CRP produced about 14-times more songbirds than crop fields. Characteristics of nesting waterfowl were similar in CRP fields and covers managed specifically for waterfowl production. Pheasant numbers three- to five-times higher after CRP plantings were established. Nest success of pheasants in CRP was greater than necessary for population growth. Although use of CRP by bobwhites was substantial, direct evidence of CRP contributing to quail population growth was lacking.

Overall, CRP provided high-quality breeding habitat for many grassland birds, including several that have experienced long-term declines in populations. Avian response to CRP is sufficient to justify efforts to maintain long-term set-aside provisions in future federal legislation.

Ryan, M. R., L. W. Burger, Jr., E. W. Kurzejeski, and T. D. McCoy. 1995. The relationships of forage quality and land capability class with vegetation on CRP lands in northern Missouri. Final Report to the Missouri Department of Natural Resources. Jefferson City. 47 pp.

Sample, D. W., and M. J. Mossman. 1990. Conclusions from the Wisconsin Department of Natural Resources study of grassland bird use of CRP and ACR (set-aside) fields. Wisconsin Department of Natural Resources, Bureau of Research. Madison. 2 pp.

Sample, D. W., and M. J. Mossman. 1993. Habitat management guidelines for grassland birds on public and private land in Wisconsin. State of Wisconsin Memorandum, Bureau of Research. Madison. 13 pp.

Major causes of decline of grassland birds likely are loss of breeding habitat associated with conversion of pasture to rowcrops, and early and frequent mowing of alfalfa. Primary goal of habitat management for grassland birds should be to maximize the diversity and viability of grassland bird populations statewide and within region. Special attention should be given to identifying large tracts suitable for management.

Samson, F., and F. Knopf. 1994. Prairie conservation in North America. Bioscience 44:418-421.

Estimates of losses of native prairie since European settlement range up to 99.9% in some states. In addition to direct losses of habitat, overgrazing and recreational uses add to the stress on remnant prairies. Fifty-five grassland species currently are threatened. Authors advocated inventory and monitoring of remaining prairie ecosystems, management to discourage establishment of woody plants and woody corridors within prairie-dominated ecoregions, and realignment of administrative boundaries along ecoregion borders to increase efficiency in inventory and monitoring.

Sargeant, A. B. 1982. A case history of a dynamic resource - the red fox. Pages 121-137 *in* G. C. Sanderson, editor. Midwest furbearer management. The Wildlife Society. North Central Section, Central Mountains and Plain Sections, and Kansas Chapter.

Red fox is a major predator of upland nesting birds. Westward expansion of agriculture created landscapes with high diversity and edge resulting in a more broad-based and stable food supply for foxes. Red fox generally increased in abundance in response to decline in coyote numbers.

Sauer, J. R., G. W. Pendleton, and B. G. Peterjohn. 1995. Evaluating causes of population changes in North American insectivorous songbirds. Conservation Biology 10:465-478.

Analysis of Breeding Bird Survey (BBS) data did not support the hypothesis that predation on breeding grounds played a causal role in population changes. Rather, results indicated that more species of Neotropical migrant birds have increased than have declined since the BBS began. Authors concluded that general declines have been recent and limited to the eastern part of continent.

Saunders, D. A. 1994. Can we integrate nature conservation with agricultural production? Landscape and Urban Planning 28:63-71.

Schenck, E. W., and L. L. Williamson. 1991. Conservation Reserve Program effects on wildlife and recreation. Pages 37-42 *in* L. A. Joyce, J. E. Mitchell, M. D. Skold, editors. The Conservation Reserve - yesterday, today and tomorrow. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-203. 64 pp.

Paper summarized conservation practices by state for Midwest region. Acres of additional prime nesting habitat provided by CRP were calculated nationwide for pheasant, meadowlark, and bobwhite quail. Authors discussed economic benefits resulting from improved recreational opportunities provided by CRP.

Schmitz, R. A., and W. R. Clark. 1999. Survival of ring-necked pheasant hens during spring in relation to landscape features. Journal of Wildlife Management 63:147-154.

Spring survival and habitat use of hen pheasants compared between Iowa study sites having high habitat diversity with 25% grassland and low habitat diversity with 9.3% grassland. There were no differences between study sites in spring survival rate (76-81%) or home range size (37-48 ha). Risk of mortality increased with amount of edge in individual's home range. Predation by mammals, especially red fox, was major cause of mortality.

Schmidt, R. J., C. L. Mullins, M. Woody, and J. Knight. 1990. New Mexico's CRP and wildlife habitat improvement. Transactions of the North American Wildlife and Natural Resources Conference 55:68-73.

General description of CRP in New Mexico, including accomplishments, other conservation, and future prospects.

Schmutz, J. K. 1987. The effect of agriculture on ferruginous and Swainson's hawks. Journal of Range Management 40:438-440.

Raptors are an important component of plains ecosystems. Paper summarized the effects of cultivation and agricultural activity on hawk density in prairie region of Alberta. Density of ferruginous hawks declined with increasing cultivation. In contrast, Swainson's hawk density was higher in areas of moderate cultivation (11-30%) than in grassland (< 10% cultivation). Swainson's hawk tolerated high levels of cultivation (< 90%); ferruginous did not. Ferruginous hawks have great affinity for land with sparse and short vegetation and avoid areas where grasses are replaced by dense and tall crops. In contrast, Swainson's hawks are more highly adapted to smaller prey common in ungrazed grassy borders of ponds, roads, and farmsteads than in intensively grazed pastures. If small patches of natural or semi-natural cover containing trees or shrubs are strategically distributed in agricultural areas, Swainson's hawks are likely to remain in reasonable numbers. Ferruginous hawks require grassland and will be common only where this land use is dominant.

Schramm, H. L. Jr., L. M. Smith, F. C. Bryant, R. R. George, B. C. Thompson, S. A. Nelle, G. L. Valentine. 1987. Managing for wildlife with the Conservation Reserve Program. Texas Technical University, Management Note 11. 6 pp.

Schwartz, C., P. Jaynes, and P. Peditto. 1995. Northeast states wildlife needs assessment for 1995 Farm Bill. Transactions of the North American Wildlife and Natural Resources Conference 60:300-306.

Authors provided general review of the land use changes, and description of existing wildlife habitats in agricultural settings and status and trends of wildlife associated with wetlands, grasslands, and early-successional habitat, and rare, threatened, and endangered species. Goals presented for grassland, wetland, forest, and riparian habitats.

Shoemaker, R. 1989. The Conservation Reserve program and its effect on land values. U.S. Department of Agriculture, Economic Research Service, Agriculture Information Bulletin No. 554. 5 pp.

Bulletin concluded that producers enrolled in the CRP in 1986 and 1987 may have earned seven percent more with CRP than without it. Land values in the United States dropped eight percent between 1986 and 1987. The CRP helped cushion the decline in all land values by an estimated 0.3%.

Snyder, W. D. 1985. Survival of radio-marked hen ring-necked pheasants in Colorado. Journal of Wildlife Management 49:1044-1050.

Study estimated survival of radio-marked hen ring-necked pheasants in Colorado. Lowest monthly survival occurred in April due to predation by great horned owls, Cooper's hawks, and prairie falcons. Coyote and feral house cats were the primary mammalian predators. Characteristics of early spring residual cover influenced hen survival. Study area contained extensive tree and shrub plantings that attracted wintering pheasants and avian predators. Pheasants associated with trees incurred a higher rate of avian predation than counterparts in habitats not containing trees.

Soil and Water Conservation Society. 1994. When Conservation Reserve Program contracts expire: The policy options. Soil and Water Conservation Society. Ankeny, Iowa. 143 pp.

Proceedings of conference held in Arlington, Virginia, 10-11 February, 1994. Invited speakers addressed the program's history, and economic, social, and biological aspects of CRP.

Southern, E. C. 1984. Farm wildlife production: What does it cost? Transactions of the North American Wildlife and Natural Resources Conference 49:159-163.

Issues that negatively influence farmers' willingness to produce wildlife included (1) harassment and problems associated with increased hunting pressure and demand; (2) increased crop damage; and (3) loss of income from diverted lands. Effects of delayed haying were lower quantity and quality of hay forage. For example, dairy cows fed late-cut hay would require 1.5- to 2-times more grain supplement; the grain mixture needing to contain an additional 5% protein.

Can it be expected that farmers will carry the cost of providing wildlife habitat? The answer is reflected in the continued removal of wetlands, idle areas, and fencerows. If the costs of wildlife are compared to the costs of agricultural products (grain, hogs) the costs of production on prime farmland are very high. Raising pen-reared birds is a comparative bargain at these prices. Compensation to the farmer for wildlife habitat would probably need to be at least equal to 75-80% of the market value of the yield per acre of crop normally produced on set-aside land. Meaningful increase in wildlife numbers probably will require that at least 5% of land be devoted to wildlife habitat.

Any solution to production of wildlife on farmland must include the acceptance of farming practices that produce wildlife as a no-cost, byproduct of production. Agencies need to aggressively advocate and demonstrate farming technologies that help both the farmer and wildlife. The best approach for farmland wildlife management is to deal with resources and programs that encourage sound land use for all resources over the long-term. Wildlife's only hope on prime farmland is farm practices, programs, and policies that bring reduced costs or added income to the individual farmer.

Sovada, M. A., M. C. Zicus, R. J. Greenwood, D. P. Rave, W. E. Newton, R. O. Woodward, and J. A. Beiser. 2000. Relationships of habitat patch size to predator community and survival of duck nests. Journal of Wildlife Management 64:820-831.

Duck nest success and predator community composition examined in relation to size of discrete CRP fields in Prairie Pothole Region of United States, 1993-1995. The effect of patch size on nest success was influenced by date in nest initiation and year, but within-year comparisons for early and late nests suggested that nest success generally increased with size of CRP plot. Habitat features associated with activity indicators varied among predator species. Although authors were unable to identify CRP characteristics necessary to ensure duck nest success above threshold levels, they strongly recommend against creation of small isolated tracts without predator controls.

Stauffer, D. F., G. A. Cline, and M. J. Tonkovich. 1990. Evaluating potential effects of CRP on bobwhite quail in Piedmont, Virginia. Transactions of the North American Wildlife and Natural Resources Conference 55:75-76.

Conversion of cropland to permanent introduced herbaceous cover is likely to have a positive effect on the quality of quail habitat, but beneficial effects are likely to endure only so long as a suitable grass-forb mixture is maintained. If grasses such as tall fescue become dominant and form dense sod, then beneficial effects will be reduced.

As croplands are converted to pine plantations, the quality of converted areas for quail will decline. For the first five to seven years after conversion, plantations typically will furnish suitable herbaceous cover; however, the ability of the habitat to provide minimal understory cover needed by quail for nesting and brood-rearing will diminish as pines mature and the canopy begins to close. Generally, where conversion of cropland to CRP increases the overall habitat diversity and adds habitat components previously lacking, increases in quail populations can be expected. But when overall diversity in the landscape is reduced, quail populations are likely to decline. Authors concluded that the large amount of CRP being placed in pine plantations was likely to cause local declines in quail. They suggested that consideration needed to be given to the juxtaposition and interspersion of CRP; more diversity in habitat will be created by converting many smaller fields rather than by converting fewer large fields.

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.

Use of CRP by grassland-dependent species was related to availability of CRP. More than half of fields sampled were mowed during the nesting season. Twenty-one of 40 fields were disturbed prior to August. On average, disturbed fields had 51% of acreage mowed or burned. Disturbed fields had significantly lower values for Visual Obstruction Reading, percent grass canopy cover, and mean herbaceous height. Mean age of fields was five years (two to seven years). Mean field size was 20 acres (8.1 ha). Contract species dominated with 82.5% in timothy, orchardgrass, and clover. Forty-three breeding bird species used CRP fields. Use by eastern meadowlarks and bobolinks was significantly greater in unused fields. All species were numerically more abundant in CRP fields that were contiguous with other grassland habitat.

Swanson, T. M. 1992. Wildlife and wildlands, diversity and development. Pages 1-14 *in* T. M. Swanson and E. B. Barbier, editors. Economics for the wilds. Island Press, Washington, D.C.

Diversity and development need not be mutually exclusive; in fact, maintaining the diversity of wild resources is a necessary condition for sustainable development. Wild resources should be treated as an input to the development process and cannot be excluded. The conservation of biodiversity implies the need to conserve not only a given stock of wildlife, but the capacity for the species to mix and evolve in an ongoing interactive process. In other words, the habitat must be provided that will meet the needs of the targeted species across the landscape as well as through time. Important to integrate the value of wildlife/biodiversity into the economic process rather than shield them from it. The economic value of resources will be the key to their continuing survival.

Swengel, S. R., and A. B. Swengel. 1999. Correlations in abundance of grassland songbirds and prairie butterflies. Biological Conservation 90:1-11.

Study in 109 midwestern prairie grasslands suggests that conservation programs benefiting grassland birds can be favorable for prairie specialist butterflies and that certain bird and butterfly species can be effective indicators for one another. Implication is that distantly related animal taxa can, in some cases, be useful indicators for habitat quality for each other.

Szentandrasi, S., S. Polasky, R. Berrens, and J. Leonard. 1995. Conserving biological diversity and the Conservation Reserve Program. Growth and Change 26:383-404.

Effective protection of wildlife species will often take place on land used primarily for purposes other than wildlife habitat. CRP lands currently are targeted to regions (e.g., Midwest and Great Plains) that have relatively few threatened and endangered species. Paper describes method to retarget CRP to address T&E species concerns in Oregon or other regions where there are greater numbers of these species. Authors argued that there is need for improved targeting of CRP if it is to continue to provide important environmental benefits. Primary agencies involved in management and monitoring of the CRP (USDA) do not have a traditional wildlife-oriented mission; consequently, species preservation and habitat protection considerations have been inadequately considered.

Taylor, M. W., C. W. Wolfe, and W. L. Baxter. 1978. Land use change and ring-necked pheasants in Nebraska. Wildlife Society Bulletin 6:226-230.

Study of the effects of land use changes on ring-necked pheasants in Nebraska. Positive relationships were detected between spring densities of hens and length of fencerows, acreage of pasture and hay, and area of wheat and wheat stubble. Populations were inversely related to area of rowcrops, percent of land that was fall-tilled, and acreage of irrigated land. Irrigation generally involved extensive land leveling or clearing which eliminated idle areas, fencerows, old farmsteads, wetlands, and other habitats of high wildlife value. Tillage of crop residue in fall, especially wheat stubble, reduced cover for wildlife. Interspersion index was useful for predicting pheasant habitat quality and density of birds.

Thogmartin, W. E. 1999. Landscape attributes and nest site selection in wild turkeys. Auk 116:912-923.

Evaluation of landscape habitat characteristics that were important for placement and survival of wild turkey nests in the Ouachita Mountains, Arkansas. Hens selected short-leafed pine (68%) over mixed hardwoods (24%) and other habitats (8%). Fifty-eight percent of hens nested in edge habitat, but placement in such areas did not influence nest success. Hens nested in large patches away from areas of high edge density favored by predators. Nests located close to roads were uniformly unsuccessful. Habitat characteristics were good predictors of nest location but poor predictors of success. Author concluded that high abundance of edge in the landscape sustained predator populations and contributed to reduced nest success in large patches.

Thomas, M. B., S. D. Wratten, and N. W. Sotherton. 1991. Creation of island habitats in farmland to manipulate populations of beneficial arthropods: Predator densities and emigration. Journal of Applied Ecology 28:906-917.

Replacement of natural vegetation by crop monocultures can eliminate many indigenous insects. Diversification of habitat structure on both macro and micro scales will enhance abundance and diversity of insect populations. Decreased diversity of habitats associated with field enlargement resulted in lower density of insects in interiors of larger fields.

Thompson, F. R., S. J. Lewis, J. Green, and D. Ewert. 1993. Status of Neotropical migrant landbirds in the Midwest: Identifying species of management concern. Pages 145-158 *in* D. M. Finch and P. W. Stangel, editors. Status and Management of Neotropical migratory birds. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-229. 422 pp.

Authors outlined ecosystem management approach that addressed the needs of the many species of high management concern in the Midwest. Grasslands were identified as one of several habitats that deserved special management attention. Grassland species of special management concern were (in order of decreasing importance): Baird's sparrow, dickcissel, mountain plover, bobolink, long-billed curlew, grasshopper sparrow, lark bunting, upland sandpiper, burrowing owl, scissor-tailed flycatcher, Swainson's hawk, lark sparrow.

Trautman, C. G. 1982. History, ecology and management of the ring-necked pheasant in South Dakota. South Dakota Department of Game and Parks. 118 pp.

Winter concentrations of pheasants were often located near weed patches, grain stubble, cornfields, and other food sources. Distances traveled rarely exceeded ¼ mi. Proximity to available food was the dominant factor in choice of winter roosting sites. Marshlands provide high quality winter cover. Author provided a detailed description of ring-necked pheasant history, ecology, and management in South Dakota.

Trenbath, B. R., G. R. Conway, and I. A. Craig. 1990. Threats to sustainability in intensified agricultural systems: Analysis and implications for management. Pages 337-365 *in* S. R. Gliessman, editor. Agroecology: Researching the ecological basis for sustainable agriculture. Springer-Verlag, New York.

Agricultural intensification usually results in (1) a greater proportion of available land more intensively farmed; (2) an elevated level of technological input; and (3) more frequent use of a given area. The combination of these effects is often accompanied by damage to the natural resource base. May damage nonagricultural systems inside and outside of the developed area as well as other agricultural systems downstream of the area. Intensive exploitation of available area has led to increases in productivity but commonly leads to decline in wildlife populations. Where wildlife viability is dependent upon relatively large patches of less disturbed habitat, populations may disappear.

The more frequent use of land is a common aspect of intensification that is potentially exhaustive of land capability. With shorter fallow period between crops, natural soil processes may be unable to regenerate fertility and there may be a build up of pests—both of which require greater use of agrochemicals to alleviate problem. Use of pesticides may initially lead to spectacular increase in yields, but experience suggests that after a number of years of application, pesticides progressively lose their effectiveness. Decline in effectiveness is due to an increased proportion of pest genotypes in population that are resistant to chemicals. If use continues, especially at higher dosages, the proportion of resistant genotypes increases rapidly to point where the pesticide must be replaced by new chemical. Emergence of pesticide resistance reduces profitability because of crop losses and need for different, often more expensive, chemical.

Unevehr, L. J. 1993. Suburban consumers and exurban farmers: The changing political economy of food policy. American Journal of Agricultural Economics 75:1140-1144.

Larger trends in society frequently have implications for food and agricultural policy. Three current trends were indicated: declining importance of farms, suburbanization, and skewed distribution of income growth. Resident farm population represented < 2% of the U.S. population; farm labor accounted for < 3% of labor force. Farm population declined by 24% during the 80s. Other trends: fewer Americans have direct ties to agriculture; farming is a smaller part of the rural economy; farm resident population accounts for only 7% of rural population; farm production and prices continue to become less important to consumers; fewer farm ties means less sympathy with farmers' objectives or with agrarianism in general; reduced support for traditional farm commodity program goals. By 21st century, if not before, it was projected that suburban areas will account for more than half of U.S. population. Important political battles will focus increasingly on the important suburban vote. Suburban voters have become increasingly concerned about preserving open space and the impacts of agriculture on environmental quality and personal health. They have high expectations for public goods and possess the means to pursue desires through the political process. Pressure groups will have greater influence on policies, including agricultural legislation. There will continue to be demands for greater accountability in government spending, a trend which will affect all government programs.

U.S. Congress, Office of Technology Assessment. 1995. Targeting environmental priorities in agriculture: Reforming program strategies. OTA-ENV-640. 72 pp.

Damages associated with agricultural activity vary widely depending on how production practices affect an area's natural resources. Federal programs must be targeted to priority areas and successfully apply low-cost approaches to achieve the greatest returns for tax expenditures. Agroenvironmental priority areas were identified on a national scale for wildlife habitat; surface water, groundwater, and soil quality; rangeland; water conservation; rural landscapes; and wetlands and riparian areas. Legislation should use targeting procedure to maximize environmental benefits. Development and adoption of technologies that sustain privately profitable production and achieve environmental objectives must be linked with agroenvironmental programs.

U.S. Congress, Office of Technology Assessment. 1995. Agriculture, trade, and environment: Achieving complementary policies. OTA-ENV-617. 241 pp.

Current agricultural and environmental policies do not promote interests of U.S. farmers, traders, consumers, or taxpayers efficiently. Many policies are in conflict and may impede the nation's environmental priorities. Document described connections among agriculture, trade, environment, and related government policies and programs. Report concluded that many agricultural programs were obsolete and were not accurately targeted. Research on environmental issues related to agriculture was dramatically underfunded. Government needed to define and adopt policies that expanded U.S. agricultural exports and upgraded environmental quality associated with agricultural land use and production.

U.S. Department Agriculture. 1993. Conservation Reserve Program: Cost-effectiveness is uncertain. U.S. General Accounting Office, GAO/RCED-93-132. 14 pp.

Precise balance between the costs and environmental benefits of CRP cannot be calculated because dollar value of the environmental benefits from the program cannot be accurately assessed. The USDA has not quantified the effect on the environment of removing enrolled acres from production. USDA will pay more than $91 billion to remove 63.5 million acres from production over 10-year life of the program. Benefits perceived to be only temporary. USDA goals for the program were to reduce commodity production, support farm income, and to provide environmental benefits. As a result of these other goals, projects with fewer environmental benefits were initially allowed into the program. Other USDA programs (Conservation Compliance, Agricultural Conservation Program, and Small Watershed Program) were identified as covering more acres of cropland, costing less, and providing more long-term environmental benefits. However, these programs were not intended to curb excess production and only indirectly supported farm incomes. Advantages of these programs were that they do not take land out of production.

U.S. General Accounting Office. 1989. Farm Programs: Conservation Reserve Program could be less costly and more effective. Report to the Chairman, Committee on Agriculture, Nutrition, and Forestry, U.S. Senate. GAO/RCED-90-13. Washington, D.C. 79 pp.

USDA could improve effectiveness of CRP by targeting cropland eroding at the highest rates and land that contributed most to surface water and groundwater contamination. CRP cost will be offset to some extent as farmers enroll acres that would otherwise be used for growing crops covered by price and income support programs. USDA incurred additional cost in tree planting initiative in five southeastern states. Higher rental rates were paid to all farmers regardless of whether they planted trees. USDA instructions to local county offices allowed CRP rental rates in many areas to exceed local rental rates. Report recommended that USDA implement competitive bid system and modify the 25% limit on acreage to allow more flexibility in program enrollment.

U.S. General Accounting Office. 1995. Conservation Reserve Program: Alternatives are available for managing environmentally sensitive cropland. GAO/RCED-95-42. Washington, D.C. 68 pp.

Vance, D. R. 1976. Changes in land use and wildlife populations in southeastern Illinois. Wildlife Society Bulletin 4:11-15.

Paper summarized consequences of land use changes on wildlife populations in southeastern Illinois from 1939 to 1974. Extensive grasslands and fencerows were reduced by 48%. Intense cash-grain farming was expected to cause further declines in habitat and populations. Soybeans had largely replaced grassland. Remaining grassland (1% of area) was overgrazed pasture. Three major components of habitat, grassland, woody cover, and edge, were reduced by intensification of agricultural production. What remains of edge was of little value because of lower structural diversity. Author stated that 14 species of birds had declined due to loss of grassland, edge, and savanna type habitats in southeastern Illinois.

Voigt, D. R. 1987. Red fox. Pages 378-392 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch, editors. Wild furbearer management in North America. Ontario Ministry of Natural Resources, Toronto, Canada.

Increases in red fox numbers were associated with declines in coyote. Competition with other canids, particularly coyote, strongly influenced numbers of fox but not their distribution. Foxes avoided raising pups in areas where coyotes had established a home range.

Voigt, D. R., and B. D. Earle. 1983. Avoidance of coyotes by red fox families. Journal of Wildlife Management 47:852-857.

Foxes avoided raising pups in areas where coyotes traveled and raised pups. Coyote ranges were five- to seven-times larger than fox territories and may significantly limit the number of fox families in an area.

Wachob, D. G. 1997. The effects of the Conservation Reserve Program on wildlife in southeastern Wyoming. Ph.D. dissertation. University of Wyoming, Laramie.

Study conducted in southeastern Wyoming in 1993-1994 related vegetative and spatial characteristics of CRP to habitat use by nongame birds, small rodents, sharp-tailed grouse, raptors, carnivores, and big game. Annual differences in nongame bird responses to vegetative structure and occurrence of alfalfa, but nongame bird use was unrelated to spatial characteristics of CRP. Small mammal use was affected by vegetative (species richness, height, and SD of cover) and spatial characteristics (area). CRP was used by sharp-tailed grouse for nesting and brood-rearing and associated with size and number of leks. Simulations of hypothetical landscape for 28 common species suggested species richness increased rapidly as CRP coverage increased from 0 to 15% and less rapidly between 15 and 50%.

Warner, R. E. 1992. Nest ecology of grassland passerines on road rights-of-way in central Illinois. Biological Conservation 59:1-7.

Availability of suitable grassland cover has decreased in response to increased in rowcrop farming. Fescue stands sustained relatively few breeding birds. Where farming was diversified and habitat conditions were favorable, rights-of-way and other linear habitats received high use by birds. Use was influenced by habitat condi-

tions in vicinity of the strip and regional land uses. Managed roadsides were important to passerines even where hayland was present because most nests in haylands were destroyed during cutting. Management recommendations were (1) seed areas to brome-alfalfa and or native grasses and forbs; (2) delay mowing until after August 1; (3) maximize strip width; (4) shelterbelts and woody plants should be established in some areas to enhance diversity of species.

Warner, R. E. 1994. Agricultural land use and grassland habitat in Illinois: Future shock for midwestern birds. Conservation Biology 8:147-156.

During the period of most intensive agricultural production, grasslands existed only as linear edges with resultant low density and diversity of grassland nesting birds. Nest densities and species diversity were highest where grassland was nearby, cover types were heterogeneous, and where corridors connected grasslands in surrounding landscape. Nest destruction was high in years when both predators and nesting pheasants were concentrated in relatively little grassy cover. The percentage of pheasant nests hatched annually from 1973 to 1981 was positively correlated with the amount of grassland per hen in spring, where grassland was defined as both edge habitats (including roadsides) and fields of hay and small grain. Landscape characteristics were associated with use of edges by nesting birds and reproductive success. Nest densities and species diversity increased with spatial heterogeneity and connectivity in the landscape. Use of grassy farmland edges would be enhanced by establishing herbaceous buffer strips along field borders and existing edges, and by locating hay and small grains near grassland corridors. Not all linear habitats are predator traps. Predation rates vary with predatory-prey assemblages, density of birds in nest habitats, and extent to which other cover and prey attract predators away from relatively attractive nest sites. Landscape-level phenomena poorly understood at this time.

Warner, R. E., L. M. David, S. L. Etter, and G. B. Joselyn. 1992. Costs and benefits of roadside management for ring-necked pheasants in Illinois. Wildlife Society Bulletin 20:279-285.

Mitigating the effects of agricultural land use on upland wildlife remains a challenge to resource agencies. Successful habitat programs in agricultural environment are those that are compatible with farming operations. Habitat initiatives are rarely evaluated relative to their effect on target species, economics, or the perceptions of cooperating landholders. Roadside rights-of-way are frequently mowed during the growing season and, consequently, have little habitat value for nesting pheasants. Paper summarized economic costs and benefits of roadside seeding and maintenance in relation to improved habitat availability and production of pheasants.

Warner, R. E., and S. L. Etter. 1985. Farm conservation measures to benefit wildlife, especially pheasant populations. Transactions of the North American Wildlife and Natural Resources Conference 50:135-141.

Authors suggested that three spatial factors were key to understanding the interaction of agriculture and pheasants: (1) field, primary site for particular biological needs; (2) farm, represents a unit of land management and describes cover types near sites of biological activity; (3) region, mosaic of cover over an extended area that encompasses several farms. All scales influence the occurrence, location, and outcome of specific events in the life of pheasants. Scales vary in importance from season to season depending upon weather, type of farming, and biological activity. Regional scale is important to movements during crop harvest, fall tillage, winter grouping, and spring dispersal. Farm scale is important during brood-rearing and establishment of territories. Field scale most relevant to nest success, roosting, and predation.

Ideally, management practices should extend over several contiguous townships. Habitat should be adequate to permit movements of birds from farm-to-farm in response to individual farm management activities. Conservation measures must be extensive and long-term to significantly benefit pheasant populations. Addressing factors that are critical during the reproductive season are first priority.

Warner, R. E., and S. L. Etter. 1986. The dynamics of agriculture and ring-necked pheasant populations in the Cornbelt, U.S.A. World Pheasant Association Journal 11:76-89.

Warner, R. E., S. L. Etter, L. M. David, and P. C. Mankin. 2000. Annual set-aside programs: A long-term perspective of habitat quality in Illinois and the Midwest. Wildlife Society Bulletin 28:347-354.

Description of land use changes in Illinois and trend toward short-term set-aside programs between 1962-63 and 1991-94. Annual set-asides were inadequate to preserve diversity and abundance of prairie-nesting birds. Study documented diminution in measured habitat attributes (heterogeneity of vegetation, disturbance during growing season, persistence of vegetation between years, connectivity of grassy fields) between 1962-63 and 1991-94. Authors recommended multi-year set-asides with grassland preserves and development of sustainable farming systems that accommodate wildlife.

Washburn, B. E., T. G. Barnes, and J. D. Sole. 2000. Improving northern bobwhite habitat by converting tall fescue fields to native warm-season grasses. Wildlife Society Bulletin 28:97-104.

Evaluation of the efficacy of techniques to kill tall fescue and establish native warm-season grasses to improve habitat for northern bobwhite quail in Kentucky. Best treatment to kill tall fescue and establish native warm-season grasses was a spring burn followed by a preemergence imazapic application and seeding of native warm-season grasses.

Weitman, D. 1994. Water quality improvement and wetlands restoration. Pages 20-22 *in* When Conservation Reserve Program contracts expire: The policy options. Soil and Water Conservation Society. Ankeny, Iowa.

Water quality benefits of CRP and wetland restoration were unknown. Nonetheless, author argued that because agriculture was the most significant cause of water quality problems, CRP must be tailored to focus on water quality priorities to contribute significantly to national clean water strategy. Two million acres of riparian areas may be most cost-effective way to protect water quality through CRP. Author recommended that program be restructured to promote long-term easements.

Westemeier, R. L. 1983. Responses and impact by pheasants on prairie chicken sanctuaries in Illinois: A synopsis. Pages 117-122 *in* R. T. Dunabe, R. B. Stiehl, and R. B. Kahl, editors. Perdix III: Gray partridge and ring-necked pheasant workshop. Wisconsin Department of Natural Resources, Madison.

Western, D. 1989. Conservation without parks: Wildlife in the rural landscape. Pages 158-165 *in* D. Western and M. C. Pearl, editors. Conservation for the twenty-first century. Oxford University Press, New York.

Whitmore, R. 1982. Insect biomass in agronomic crops as food for ring-necked pheasant chicks. Ph.D. dissertation. University of Nebraska, Lincoln. 64 pp.

Corn, soybeans, and alfalfa had significantly lower amounts of insect biomass than wheat, oats, sweetclover, and oats-sweetclover. Estimated number of chicks/ha supported by insect biomass in various crops was 8 in corn, 10 in soybeans, 64 in sweetclover, 86 in oats, and 106 in oats-sweetclover.

White, B. 1992. Managing CRP grasslands for bobwhite quail. U.S. Soil Conservation Service, Biology Technical Note MO-14. 5 pp.

Whiteside, R. W. 1983. Aspects of the ecology and management of pheasants in the high plains of Texas. Ph.D. dissertation. Texas Tech University, Lubbock. 65 pp.

Whitworth, M. R., and D. C. Martin. 1990. Instream benefits of CRP filter strips. Transactions of the North American Wildlife and Natural Resources Conference 55:40-45.

Study compared biological indices (macroinvertebrate abundance and diversity, fish, community-level biotic indices, and fish population-level indices) in Indiana and North Carolina streams with and without filter strips. Benthic macroinvertebrates and fish communities showed significant differences between buffered and nonbuffered stream segments. Authors concluded that vegetative filter strips can benefit small headwater streams in agricultural regions.

Wildlife Management Institute. 1994. America needs the Conservation Reserve Program. Washington, D.C. 16 pp.

Wildlife Management Institute. 1995. How much is enough? A regional wildlife habitat needs assessment for the 1995 Farm Bill. Washington, D.C. 30 pp.

Wildlife Society. 1995. 1995 Farm Bill: Wildlife options in agricultural policy. Wildlife Society, Technical Review 95-1. 23 pp.

Williams, B. K., M. D. Koneff, and D. A. Smith. 1999. Evaluation of waterfowl conservation under the North American Waterfowl Management Plan. Journal of Wildlife Management 63:417-440.

Paper reviewed efforts to evaluate the North American Waterfowl Management Plan. Summary provided for results from selected assessments of intensive (e.g., planted cover, electrified fencing, wetland conservation, nesting structures, nesting islands, and predator removal) and extensive management treatments (e.g., rotational grazing, delayed haying, conservation tillage, constructed wetlands, upland cover, beaver pond management). Associations between habitats and reproduction, recruitment, and survival were discussed. Authors concluded that there was need for ongoing and more carefully prioritized conservation efforts, broader partnerships, improved understanding of links between habitats and biological processes.

Williams, C. F., and J. W. Mjelde. 1994. Conducting a financial analysis of quail hunting within the Conservation Reserve Program. Wildlife Society Bulletin 22: 233-241.

Upsurge in outdoor recreation has strained the public land system. Public hunting lands remain in short supply. Authors concluded that the greatest opportunity to supply quality hunting was the development of opportunities on private land.

Willson, G. D. 1995. The Great Plains. Pages 295-296 *in* E. T. LaRoe, G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac, editors. Our living resources: A report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. U.S. Department of the Interior, National Biological Service, Washington, D.C.

Introduction to chapter reviewing effects of > 100 years of postsettlement manipulation of the Great Plains ecosystem on grassland birds, migratory birds in North Dakota, waterfowl nesting success, prairie fishes, and canids.

Wilson, S. D., and J. W. Belcher. 1989. Plant and bird communities of native prairie and introduced Eurasian vegetation in Manitoba, Canada. Conservation Biology 3:39-44.

Study examined effect of introduced plants on native plants and bird communities in a mosaic of North American mixed-grass prairie and Eurasian vegetation. All bird species were native to prairie. Bird abundance was the same in native and introduced vegetation, but two of eight species were more abundant in native than in introduced vegetation. None were more common in introduced vegetation. A correlation matrix calculated for all bird species and 10 most abundant plant species divided the bird community into two groups: western meadowlark, upland sandpiper, Sprague's pipit, Baird's sparrow, and savannah sparrow positively associated with native plants; vesper sparrow, clay-colored sparrow, and grasshopper sparrow negatively associated with native plants. Authors concluded that plant introductions had important effects on native plant and bird communities.

Winter, M. 1999. Nesting biology of dickcissels and Henslow's sparrows in southwestern Missouri prairie fragments. Wilson Bulletin 111:515-527.

A comparison of nesting biology of dickcissels and Henslow's sparrows to provide insight into factors potentially contributing to population declines in southwestern Missouri. Species nesting in tall grass prairie fragments had similar clutch sizes, rates of hatching success, and numbers of fledglings/nest, but dickcissels tended to have reduced nesting success and higher rates of brood parasitism than Henslow's sparrows. Vegetative characteristics differed between successful and depredated dickcissel nests, but no differences were detected between successful and depredated Henslow's sparrow nests or parasitized and unparasitized dickcissel nests.

Winter, M., D. H. Johnson, and J. Faaborg. 2000. Evidence for edge effects on multiple levels in tallgrass prairie. Condor 102:256-266.

Analysis of the effects of edge on predator distribution and survival of artificial nests and natural nests of dickcissels and Henslow's sparrows in native tallgrass prairie system in southwestern Missouri. Survival of artificial nests reduced along forest edge; dickcissel and Henslow's sparrow nest success was lower along shrub edge, but nest fates were unrelated to distance from roads, agricultural fields, or forests. Authors argued that edge effects were more pronounced than area effects and attributed edge effect to mid-sized carnivores. Further, species responded to edge by reducing density (Henslow's sparrows) or decreased nest success (dickcissel).

Wooley, J. R. George, B. Ohde, and W. Rybarczyk. 1982. Nesting evaluations of native grass pastures and narrow-row soybeans. Pages 5-6 *in* R. B. Dahlgren, compiler. Proceedings of Midwest Agricultural Interfaces with Fish and Wildlife Resources Workshop. Iowa State University, Iowa Cooperative Fish and Wildlife Research Unit, Ames.

Native grasses have a dense growth form similar to other types of pheasant nest cover and are unlikely to be mowed or grazed until after most eggs hatch. Leaving the recommended 20-25 cm (8-10 in) stubble to ensure optimum plant growth should provide residual cover for nesting the following spring.

Pheasant nest densities were high in both switchgrass and little bluestem, but nest success was greatest in switchgrass. Mowing operations in early June destroyed all nests and killed 8 of 11 hens nesting in alfalfa/orchard grass. Pheasant and passerine nest success was higher in switchgrass that was not grazed or mowed the previous summer. Residual cover in undisturbed switchgrass apparently was more attractive to nesting females than that in disturbed fields and resulted in greater numbers of successful nests. Switchgrass managed for nest cover should be left undisturbed.

Young, C. E., and C. T. Osborn. 1990. The Conservation Reserve Program: An economic assessment. U.S. Department of Agriculture, Economic Research Service, Agriculture Economic Report 626. 32 pp.

Young, L. S. 1989. Effects of agriculture on raptors in the western United States: An overview. Pages 209-218 *in* Proceedings of the Western Raptor Management Symposium and Workshop. National Wildlife Federation, Washington, D.C.

Young, R. E., G. M. Adams, and B. Willcott. 1994. Extending CRP contracts vs. commodity program costs. Pages 30-34 *in* When Conservation Reserve Program contracts expire: The policy options. Soil and Water Conservation Society, Ankeny, Iowa.

Analysis of the effects of CRP extensions on commodity support budget. Authors concluded extension of CRP would serve to tighten commodity supplies, thereby pushing commodity prices up and reducing deficiency payments.

Zinn, J. 1993. The next generation of U.S. agricultural conservation policy. Soil and Water Conservation Society, Ankeny, Iowa. 40 pp.

White paper based on results from National Soil and Water Conservation Society forum (March 14-16 1993) of stakeholders and interest groups to assess how current agricultural policies were working. Paper provided detailed summaries of current strong and weak points pertaining to effects of agricultural policies on environmental issues. Paper also presented results of regional focus group, summary of problems, and potential solutions to agriculturally related issues.