MANAGEMENT OF NORTHERN PRAIRIES AND WETLANDS FOR THE CONSERVATION OF NEOTROPICAL MIGRATORY BIRDS

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ABSTRACT.—Grasslands and wetlands of the northern prairies provide important breeding habitat for a number of birds. Deciding which species deserve most attention in managing those habitats depends, in part, on the importance of the area to the species. Many species in northern prairies are more common elsewhere and need no special consideration in that area. Several species, however, are critically dependent on the prairies. These species merit particular attention if protection of biodiversity is a goal.

Both grasslands and wetlands in the northern prairies have been extensively converted for agricultural use, which has reduced the value of these habitats for breeding birds. Most land-use changes took place before monitoring programs for birds began, so quantitative assessments of changes in avian populations are lacking. This paper discusses the status of bird populations in the northern prairies, key upland and wetland habitats, effects of common management practices, and issues that specifically result from a landscape perspective. Most management practices are employed for other objectives; consequences to nongame birds are incidental, but vitally important to some species.

The northern prairies constitute a major breeding area for many wetland- and grassland-dependent species of birds. I review the status of bird populations in the northern prairies, key upland and wetland habitats, effects of common management practices, and issues that specifically arise from a landscape perspective. I focus on the United States portion of the northern tallgrass and mixed-grass prairies, including northern Iowa, western Minnesota, portions of North Dakota and South Dakota east of the Missouri River, and northeastern Montana. Certain conclusions will be more widely applicable, especially to the southern prairie provinces of Canada.

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BIRD POPULATIONS OF THE NORTHERN PRAIRIES

A large number of bird species breed in the northern plains. The avifauna includes species of boreal, eastern, southern, and western affinities (Stewart 1975, Johnsgard 1979). Most species are more common elsewhere; I emphasize species for which the area is important because it supports a significant proportion of the species' population. I concentrate mostly on neotropical migrant landbirds, although some short-distance migrants are also included for completeness and comparison (table 1).

Stewart (1975) classified the breeding birds of North Dakota according to their biogeographical affinities (table 2). Of the 190 species included, 56 (29 percent) were associated with the north-central, mixed-grass avifauna. Those 56 species made up 80 percent of the total breeding bird population in 1967 (excluding exotic species).

Table 1.—*Migratory status*[a] *and population trends*[b] *(based on BBS results in the Central Region) of birds of the northern prairies.*

Species	Trend 1966-1994	Trend 1966-1979	Trend 1980-1994
PRIMARILY NEOTROPICAL MIGRANTS			
Swainson's hawk	0.9	1.3	1.6
Upland sandpiper	2.1 ↑↑↑	3.7 ↑↑↑	0.3
Burrowing owl	-2.8	2.3	-0.5
Willow flycatcher	NA	NA	NA
Western kingbird	1.1 ↑↑↑	1.0	-0.0
Eastern kingbird	0.2	0.4	0.4
Common yellowthroat	-0.9 ↓↓↓	1.8 ↑↑↑	-2.1 ↓↓↓
Dickcissel	-1.0 ↓↓↓	-4.5 ↓↓↓	1.3 ↑↑↑
Clay-colored sparrow	-1.1	-0.9	0.9
Lark bunting	-0.7	-4.0 ↓↓↓	1.1
Baird's sparrow	-0.9	-4.0 ↓	-0.5
Grasshopper sparrow	-2.9 ↓↓↓	-2.6 ↓↓↓	-1.8 ↓↓
Bobolink	-2.4 ↓↓↓	-3.2 ↓	-3.0 ↓↓↓
Yellow-headed blackbird	0.5	3.3	-2.1 ↓↓
PRIMARILY TEMPERATE MIGRANTS			
Northern harrier	-2.1 ↓↓	-1.9	-0.3
Ferruginous hawk	6.2 ↑↑	5.5	11.6 ↑↑↑
Killdeer	-0.3	3.0 ↑↑↑	-2.0 ↓↓↓
Willet	-1.8	4.7 ↑↑↑	-0.4
Marbled godwit	0.7	7.9 ↑↑	—
Short-eared owl	2.0	27.7 ↑	-0.5
Horned lark	-0.6	-0.2	-1.1 ↓↓↓
Sedge wren	1.3	-4.1 ↓↓	5.7 ↑↑
Marsh wren	3.6	-4.9 ↓↓	6.7 ↑↑↑
Gray catbird	-1.0	0.7	-0.8
Sprague's pipit	-0.1	-6.5 ↓↓↓	3.0
Loggerhead shrike	-3.1 ↓↓↓	-4.3 ↓↓↓	-1.3 ↓↓
Vesper sparrow	0.4	0.3	1.1 ↓
Lark sparrow	-3.8 ↓↓↓	-5.6 ↓↓↓	-2.8 ↓↓↓
Savannah sparrow	0.5	-2.0	1.5
Song sparrow	1.4 ↑↑↑	-0.2	2.8 ↑↑
Swamp sparrow	1.3	6.3 ↑↑↑	2.5
McCown's longspur	3.7	11.0 ↑↑	5.8
Chestnut-col. longspur	-0.4	0.5	-0.6
Red-winged blackbird	-0.5 ↓↓	1.1 ↑↑↑	-1.3 ↓↓↓
Western meadowlark	-0.3	-1.1 ↓	0.3
Brown-headed cowbird	-0.5 ↓	2.5 ↑↑↑	-0.2
PRIMARILY PERMANENT RESIDENTS			
Greater prairie-chicken	-0.9	16.8 ↑↑↑	5.4
Sharp-tailed grouse	3.8 ↑	2.7	8.0

[a] Based primarily on Gauthreaux (1992).

[b] Estimated annual percentage change;
↑ increasing at $P < 0.10$; ↑↑ increasing at $P < 0.05$; ↑↑↑ increasing at $P < 0.01$; ↓ decreasing at $P < 0.10$; ↓↓ decreasing at $P < 0.05$; ↓↓↓ decreasing at $P < 0.01$.

Table 2.—*Faunistic composition and total population composition of breeding birds in North Dakota (Stewart 1975).*

Avifauna	Composition by species	Composition by population
North-central North America (mixed-grass)	56 (29%)	80%
Eastern North America[1] (mostly woodland)	71 (37%)	13%
Western North America[1]	37 (19%)	6%
Northern North America	31 (16%)	1%

[1] Five species are included in both eastern and western avifaunas.

I suggest species deserve special attention in the northern prairies if a significant portion of their population breeds in the area and they meet any of the following other criteria: (1) their breeding range is small, (2) their total (continental) population is small, (3) they have declined in number or contracted in geographic range, (4) they are restricted to a narrow range of habitats, especially if those habitats are threatened, or (5) there is some major potential threat to their population. The most compelling reason for emphasizing any particular species in an area is that the area supports a substantial portion of the continental population of the species. That point may seem obvious, but considerable management attention is directed toward species in insignificant portions of their range (as noted, for example, by Knopf 1992). This effort may be appropriate if such peripheral populations are genetically distinct from central populations and offer greater potential for adaptation to changing environments (Lesica and Allendorf 1995), but that situation is unlikely to hold for widely dispersing migratory birds. With this perspective, the scheme used by Partners In Flight provides a prioritization scheme for landbirds, based on perceived threat of extinction (Hunter *et al.* 1993). Alternatively, a focus on endemic species (e.g., Knopf 1988) is valuable but may miss some species that are not endemic but in need of attention.

By such criteria, species such as Baird's sparrow and Sprague's pipit, which have small populations and whose breeding ranges are restricted to the northern Great Plains, deserve more attention in that area than do species such as the brown thrasher and yellow warbler. The latter species also breed in the northern Great Plains, but their distributions are far broader, and they are more common elsewhere. Even in the Plains, they can use artificial habitats such as shelterbelts and suburban plantings, which are increasingly common. Conversely, the Baird's sparrow and Sprague's pipit require grassland, the natural habitat on the northern Plains.

Status and Trends

The mid to late 1960's is a convenient reference point for the status of bird populations in this region. The Breeding Bird Survey (BBS) began in 1966 and became operational in the region in 1967. Also, a statewide survey of North Dakota birds was conducted in 1967 (Stewart and Kantrud 1972); a repeat of that survey in 1992 and 1993 provides a useful contrast (Igl and Johnson 1995b). Considering population changes during the last 25 years or so can be misleading, however. Most of the major changes in habitat in the northern prairies occurred after settlement by Europeans but before the 1960's, and associated changes in bird populations were not tracked by BBS or other programs. Our knowledge of bird populations prior to European settlement is weak, based on comments by early explorers and settlers or inferred from current bird use of habitats that have not been altered dramatically.

Early reports mention huge numbers of waterfowl, shorebirds, and other birds (e.g., Dinsmore 1994). The reports lack quantification, and it is questionable whether low numbers or absences would be reported as faithfully as extreme abundances. Nonetheless, many of the accounts describe grassland birds in numbers unheard of today.

BBS results indicate that during 1966-1991, grassland-nesting birds had a higher proportion of declining species than did any other avian guild in North America (Droege and Sauer 1994, Knopf 1994). BBS trends for the 1966-1994 period are given in table 1 for the Central Region, roughly the area between the Rocky Mountains and the Mississippi River.

From 1966 to 1994, significant decreases outnumbered significant increases by four species to two among neotropical migrants, and by five species to two among temperate migrants (table 1). During the more recent period (1980-1994), significant declines outnumbered significant increases by four to one for neotropical migrants and matched them at five to five among temperate (short-distance) migrants. Declines were consistent in both early (1966-1979) and late (1980-1994) periods for only the grasshopper sparrow, bobolink, and Baird's sparrow, among neotropical migrants, and for northern harrier, horned lark, loggerhead shrike, and lark sparrow, among temperate migrants. Increases were consistent in both time periods for the neotropical migrants, Swainson's hawk, upland sandpiper, and eastern kingbird; for the temperate migrants, ferruginous hawk, vesper sparrow, swamp sparrow, and McCown's longspur; and for the permanent resident sharp-tailed grouse.

Populations of temperate migrants in North Dakota in 1992-1993 did not differ consistently from those in 1967 (Igl and Johnson 1995b; table 3). Numbers of long-distance migrants increased, however, and those of permanent residents more than doubled from the early to the recent period. Examining bird populations by primary breeding habitat, Igl and Johnson (1995b) concluded that species that rely on trees (open habitat with trees, woodland and woodland-edge, and residential-generalist) consistently increased from 1967 to 1992-1993 (table 3). Trends for groups of species associated with other habitat types were not evident.

Such groupings, however, can disguise changes occurring to particular species. Among the grassland birds, numbers of chestnut-collared longspurs, western meadowlarks, savannah sparrows, and Baird's sparrows declined by 39 percent or more; clay-colored sparrows and bobolinks declined at lesser rates (table 4). Horned lark and lark bunting numbers varied without a trend, likely due to changes in precipitation during the study years. Counts of vesper sparrows and upland sandpipers increased by more than 50 percent.

Table 3.—*Mean number of indicated breeding pairs in 128 randomly selected quarter-sections in North Dakota by year, migration strategy, and preferred breeding habitat.*

	Mean pairs/100 ha		
Migration strategy	**1967**	**1992**	**1993**
Permanent resident	2.6	5.7	6.1
Short-distance migrant	95.5	74.7	99.5
Long-distance migrant	43.2	52.3	45.4
Breeding habitat			
Wetland/wet meadow	37.5	24.7	32.6
Grassland/open habitat	71.7	59.3	68.3
Open habitat with trees	5.5	10.6	9.7
Shrubland	7.2	7.5	9.0
Woodland/woodland-edge	15.6	24.6	25.3
Residential/generalist	3.7	5.7	5.8
Other	0.1	0.3	0.3
Total	141.3	132.7	151.0

Table 4.—*Number of indicated pairs of the 20 most common grassland bird species observed on 128 randomly selected quarter-sections in North Dakota in 1967, 1992, and 1993.*

Species	Number of indicated pairs		
	1967	1992	1993
Horned lark	1,253	1,093	1,661
Chestnut-collared longspur	1,129	602	755
Red-winged blackbird	945	597	710
Western meadowlark	926	487	646
Brown-headed cowbird	460	643	610
Lark bunting	604	679	298
Grasshopper sparrow	301	402	449
Mourning dove	292	339	337
Savannah sparrow	516	134	276
Clay-colored sparrow	364	261	289
Vesper sparrow	195	224	393
Eastern kingbird	167	321	245
Bobolink	216	186	172
Western kingbird	103	194	177
Common yellowthroat	134	91	175
American goldfinch	106	146	132
Baird's sparrow	170	77	125
Killdeer	105	112	142
Upland sandpiper	63	106	89
Wilson's phalarope	73	30	36

HABITATS OF THE NORTHERN PRAIRIES

The primary natural habitat type in the northern plains is grassland. Three broad provinces of grassland in the Great Plains are generally recognized, which correspond to a gradient of increasing precipitation from west to east: shortgrass prairie in the west, mixed-grass prairie in the center, and tallgrass prairie in the east (Risser *et al.* 1978). Patches of one grassland type can be found within another province, depending on local edaphic features, topography, precipitation patterns, and land use. The focus here will be on the mixed-grass and tallgrass prairies of the northern United States.

Prior to settlement by Europeans, the northern plains were a vast grassland; trees were scarce or absent (e.g., Bragg and Steuter 1995). Early reports indicate that trees were largely restricted to river floodplains, east- or north-facing bluffs along streams, and prominent hillsides (Stewart 1975:4, Bragg and Steuter 1995). Grasslands were maintained by periodic drought; fires, especially to the east; and, especially in the west, grazing by large herds of herbivores such as bison. These forces created mosaics of habitat ranging from heavily grazed to undisturbed (England and DeVos 1969).

In the eastern portion of the northern plains, innumerable depressions were left when the Wisconsin glacier retreated about 10,000 years ago. These wetland basins, called prairie potholes, contain water for various lengths of time in most years (Stewart and Kantrud 1971). The most ephemeral wetlands may hold spring runoff or summer rains for only a few days. At the other extreme are lakes, which almost never go dry. In between are seasonal wetlands, which in a typical year contain water from early spring until mid to late summer, and semipermanent wetlands, which in most years are wet throughout the frost-free season. Less common are alkali wetlands—large, shallow basins with such high alkalinity that salts are blown out when the wetland is dry, and where no emergent plants grow when it is wet. Another unusual wetland type is the fen, characterized by

floating or quaking mats of vegetation caused by groundwater seepage. Different wetland types support different kinds of vegetation and, in turn, different animal communities.

Critical to understanding the prairie is recognizing its dynamic nature, particularly as driven by recurring droughts. Prairie occurs primarily under semi-arid conditions. Precipitation is generally inadequate for growth of most woody vegetation, and the herbaceous vegetation favored fires and supported large herds of grazing herbivores, both features that further discouraged woody growth. Drought is essential to wetlands as well as uplands. The periodic drying of wetland basins facilitates nutrient cycling and results in high productivity when water returns (Murkin 1989).

Changes in Habitats of the Northern Prairies

Much of the terrestrial grassland habitat has been cultivated for crops. This conversion is nearly total in the eastern portion; tallgrass prairie is one of the most threatened habitats in the northern plains, with only scattered fragments remaining (Samson and Knopf 1994, Noss *et al.* 1995). Less mixed-grass prairie has been cultivated, largely because the terrain is rougher and precipitation is lower and less predictable. Irrigation has in many places rendered lands more suitable to cultivation, however. More shortgrass prairie remains, although much of it is intensively grazed by domestic livestock. Small grains such as wheat, barley, and oats are common crops in the western plains; in the east, row crops such as corn, soybeans, sunflowers, and potatoes are also planted.

Settlement of the northern plains by Europeans brought major increases of woodland. Tree claims were planted to protect farmsteads from the ever-present winds, and shelterbelts were established along field borders to reduce soil erosion, especially after the drought of the 1930's. Also, inadvertent increases of woody vegetation resulted from fire suppression by settlers (McNicholl 1988).

Prairie wetlands likewise have been altered in a number of ways. Drainage of basins to facilitate cultivation was very common, especially in the eastern prairies. Sometimes several small wetlands were drained into a larger one, which eliminated the smaller wetlands and altered the hydrology of the receiving wetland. Losses of wetland from settlement to 1980 were 27 percent in Montana, 35 percent in South Dakota, 49 percent in North Dakota, and 42 percent in Minnesota (Dahl 1990). Smaller, more temporary wetlands were more susceptible to drainage than were the larger, more permanent basins. Losses of some wetlands were partially offset by the creation of others. Stock-watering dams and dugouts have been constructed in the northern prairies, usually along intermittent streams. Several mainstem dams on rivers have created large reservoirs, although their value to breeding birds is limited.

Integration of Upland and Wetland Habitats

A landscape perspective requires consideration of broader-scale issues than does a local perspective. Diversity in a regional sense is more important than local species diversity (Knopf and Samson 1994). Maximizing the species richness of an area (species packing) is not a goal; maintaining viable populations is (Johnson *et al.* 1994b). This requires an understanding of each species' habitat needs and how different habitats relate to one another.

Species that forage in one habitat but nest in another illustrate connections between different habitats. Dabbling ducks feed in wetlands but commonly nest in upland grassland. Certain shorebirds, such as Wilson's phalarope, willet, and marbled godwit, likewise require both terrestrial and aquatic habitats. American bitterns and northern harriers will nest either in emergent wetland vegetation or in dense upland vegetation. Red-winged and yellow-headed blackbirds nest in wetlands but often forage in terrestrial habitats. Certain species take advantage of the dynamic nature of the prairies, settling in wetland cover as available, but using normally terrestrial vegetation during unusually wet periods. For example, the Le Conte's sparrow, which usually nests in wet swales, will nest in high numbers in upland grass-forb plantings during wet periods (Igl and Johnson 1995a).

Not any patch of habitat, even preferred habitat, will suffice; size of the patch may be influential. Several grassland species are area sensitive. For example, Herkert (1994a) found

that transects in larger grassland blocks were more likely to contain grasshopper sparrows, bobolinks, and savannah sparrows than were comparable transects in smaller blocks. Studies of birds in Conservation Reserve Program fields have indicated that many of the larger-bodied species such as northern harrier, short-eared owl, Wilson's phalarope, marbled godwit, and willet rarely occur in small habitat blocks (D. H. Johnson, in prep.). Marsh size and isolation influenced occupancy by wetland birds in Iowa (Brown and Dinsmore 1986). Even habitats that are used may not be effective in maintaining viable populations. Habitat patches may consistently attract breeding birds that fail to reproduce (sink habitats: Pulliam [1988]). Such areas occur in the northern plains for waterfowl (Klett *et al.* 1988, Greenwood *et al.* 1995). Although less is known about the population dynamics of passerines, cultivated fields (Rodenhouse and Best 1983) and especially hayfields (Bollinger *et al.* 1990, Frawley and Best 1991) likely operate as sink habitats.

Features in a landscape may affect bird use of habitats at some distances. Occupancy of grassland habitat can be influenced by the nearby presence of woody vegetation; Johnson and Temple (1986) reported nest densities of grasshopper sparrows were lower near trees than farther away, whereas the reverse held for clay-colored sparrows and western meadowlarks. Trees also may provide perch sites from which raptors can hunt and brown-headed cowbirds can seek host nests in which to lay their eggs. Johnson and Temple (1986) found that nest success of several grassland bird species was significantly higher for nests located far from a field-forest edge. Burger *et al.* (1994) reported similar results for artificial nests in grassland. Birds that nest in wetlands, woody areas, or human developments often forage in nearby grasslands, and may compete with grassland-dependent birds.

EFFECTS OF HABITAT MANAGEMENT

Publicly owned native grasslands are managed in several ways, but grazing and prescribed burning are the two most common active practices. Many public grasslands are left idle for long periods, however, permitting encroachment of woody vegetation and excessive build-up of litter. Further, woody species are frequently planted in grasslands.

Managers do not always state their grazing objectives, but objectives may include returning the vegetation to an assumed pristine state, favoring certain plant species or communities, reducing the accumulation of organic matter, and encouraging vegetation that supports desired wildlife species. Other objectives are economic returns and good relations with neighboring landowners who want to graze the lands. Grazing often is controversial (e.g., Fleischner 1994) because objectives often are not clearly defined and progress toward objectives may not be measured with a rigorous monitoring program (Kirby *et al.* 1992). In addition, there are numerous grazing regimes whose impacts on wildlife and habitats vary according to the type of grassland, soils, kinds of grazing animals, precipitation patterns, and other influences. It is sometimes argued that grazing by cattle represents an ecological replacement of bison grazing, but diets of the two species differ considerably (Peden *et al.* 1974, Schwartz and Ellis 1981) as do their mobility and ability to capitalize on vegetation growth over wide areas (McNaughton 1993). Moreover, the replacement of bison by cattle, and the associated fencing, reduces the heterogeneity of grazing effects and resulting habitats for some birds (Knopf 1996a).

Although grassland birds evolved with grazing animals (Knopf 1996b), the effects of grazing on birds are variable and depends on the region (Kantrud and Kologiski 1983), grazing regime, precipitation and other environmental conditions, and the species. Further, short-term effects may differ markedly from longer-term ones. Heavy grazing favors species—including burrowing owl, horned lark, and chestnut-collared longspur (Kantrud 1981)—that use shorter vegetation, but greatly reduces numbers of Sprague's pipit, sedge wren, bobolink, savannah sparrow, Baird's sparrow, Le Conte's sparrow, and common yellowthroat (Maher 1973; Owens and Myres 1973; Kantrud and Kologiski 1982, 1983; Dale 1984; Lingle and Bedell 1989). Prescott and Collister (1993) suggested that heavy grazing may reduce suitability of habitat for loggerhead shrikes in southeastern Alberta. Light grazing enhances the habitat for Baird's sparrow and clay-colored sparrow; light to moderate grazing supports higher densities of Sprague's pipit, savannah sparrow, and vesper sparrow (Kantrud and Kologiski 1983). Berkey *et al.*

(1993) suggested that short-term grazing in North Dakota likely was beneficial also to the ferruginous hawk. They deemed grazing detrimental to American bittern, northern harrier, upland sandpiper, short-eared owl, dickcissel, grasshopper sparrow, Le Conte's sparrow, and bobolink, species that prefer taller and denser grassy vegetation.

Under certain grazing systems, livestock are rotated through a series of pastures, which receive intense grazing pressure for short periods. This practice provides a patchwork of grasslands at any one time ranging from heavily grazed to idled for an entire growing season. Managers recommend these systems over season-long grazing both to enhance livestock production and to offer a variety of habitats for birds. Berkey *et al.* (1993) concluded that, as an alternative to season-long grazing, short-term rotational grazing would benefit species that favor taller and more robust vegetation, such as northern harrier, Baird's sparrow, lark bunting, and others.

Prescribed burning has similar biological, but fewer economic, objectives as grazing. Burning is made more difficult by unsafe or unsuitable weather conditions (e.g., high winds, rains), air quality concerns, personnel and equipment needs, and unfavorable attitudes by neighbors.

Burning has an immediate effect on grassland birds, although Kruse and Piehl (1986) found that 69 percent of active ground nests survived fires in mid-June. Recently burned areas are favored foraging areas for a number of species, including marbled godwits and willets. As growth resumes following a burn, habitat succession favors a sequence of species, beginning with species such as horned lark, chestnut-collared longspur, and vesper sparrow (Maher 1973, Huber and Steuter 1984, Pylypec 1991). Until the vegetation on a burned area is fully restored, the habitat is less suitable for species such as savannah sparrow, clay-colored sparrow, grasshopper sparrow, and bobolink (Tester and Marshall 1961, Halvorsen and Anderson 1980, Pylypec 1991, Herkert 1994b). Fire was a natural phenomenon in the northern plains and maintained the prairie. It may be an essential tool for managers who want to continue to maintain prairie and support true grassland birds. Fire and grazing occurred together naturally, and studies are needed of the interactive effects of these practices.

Often trees and other woody species are planted in grassland areas. Reasons for such plantings include aesthetic considerations, creation of habitat for game species such as deer and pheasants, and increased local species diversity (Cable *et al.* 1992). Even without an active planting program, encroachment by woody vegetation in grassland is favored by leaving the land idle, especially by protecting it from fire (Knopf 1994).

Grasslands invaded by woody species typically contain more bird species than those without (Arnold and Higgins 1986). These species tend to be edge or generalist species, such as brown thrasher, gray catbird, song sparrow, American robin, and common grackle. Such species have plentiful habitat elsewhere, and their populations are robust. Meanwhile, the addition of trees may reduce the quality of habitat for true grassland species, such as Sprague's pipit, Baird's sparrow, and short-eared owl. These species have much more restricted habitats or breeding ranges and require maintenance of prairie for their viability.

Woody vegetation can influence grassland birds in several ways. First, it reduces the area of grassland and fragments it; there is evidence that certain grassland birds, like some forest species, are area-sensitive. Second, it precludes certain species from using an area (Whitmore 1981, Kahl *et al.* 1985). Third, trees and shrubs provide perches for raptors and cowbirds, and travel lanes for mammalian predators. And fourth, species attracted to the woody vegetation may forage in adjacent grasslands and compete with prairie species.

Attempts are sometimes made to restore prairie after it had been cultivated (e.g., Thompson 1992). Although many native grasses and some forbs can be seeded with relative ease, prairie restoration is practical only for relatively small tracts of land. Use of restored grasslands by breeding birds is little-studied, but Blankespoor (1980) found that restored prairies in South Dakota supported breeding populations of grasshopper sparrows, dickcissels, common yellowthroats, and other species 2 to 4 years after planting. Grasshopper sparrows, Henslow's sparrows, bobolinks,

and eastern meadowlarks colonized prairie restorations in southern Wisconsin and established sizable and apparently stable populations within 4 to 5 years (Volkert 1992).

Former croplands are often replanted with mixtures of native and introduced grasses and forbs, especially legumes. These planting are made for several purposes, including providing habitat for upland-nesting ducks, enhancing soil quality, and reducing soil erosion. For example, the Soil Bank Program of the 1960's and 1970's and the Conservation Reserve Program of the 1980's and 1990's resulted in the retirement of vast areas of cultivated land and their conversion to mixtures of grasses and legumes. Such programs do not recreate natural habitats, but they do provide productive habitats for a variety of grassland birds (e.g., Duebbert 1981, Higgins *et al.* 1984, Renken and Dinsmore 1987). Johnson and Schwartz (1993) found that many species, including lark bunting, grasshopper sparrow, western meadowlark, clay-colored sparrow, bobolink, and sedge wren were relatively common in CRP fields in the northern plains, whereas they occurred far less commonly in croplands of the type that CRP replaced.

The most important practice for wetlands is protection from drainage. This goal can be achieved by purchasing in fee title, by buying easements that prevent drainage, by legal proscription, by tax incentives, or by encouraging wetland owners in other ways (Johnson *et al.* 1994a). Wetland preservation obviously protects a number of wetland-dependent species. In addition, programs such as the U.S. Fish and Wildlife Service's wetland acquisition program also acquire uplands surrounding the wetlands, which protects and restores grasslands.

Many wetlands are restored, usually by undoing the ditch or tiling used to drain the wetland (Galatowitsch and van der Valk 1994). Wetland restoration is more readily achievable than prairie restoration, but the degree to which a restored wetland performs the ecological functions of a natural wetland varies from one situation to another. Wetlands can be created even where they did not occur previously. This practice is sometimes done to mitigate for wetland losses elsewhere. Restored or created wetlands should support the customary wetland avifauna if they develop the vegetative and invertebrate communities of natural wetlands. Delphey and Dinsmore (1993) suggested that the absence of low-prairie and wet-meadow zones in restored wetlands in Iowa may have contributed to reduced bird use compared with natural wetlands. Although considerable effort has been expended in restoring wetlands in the northern plains, relatively little attention has been paid to evaluating the restorations. An extensive interagency effort is underway to remedy that situation (N. H. Euliss, Northern Prairie Science Center, pers. comm.).

Wetland managers often sought to increase the permanency or depth of wetlands, with the thought of minimizing the effects of dry seasons and years. The unfortunate consequences of this practice include reductions in desirable emergent plant communities (Kadlec and Smith 1992) and invertebrate populations. Maintaining the natural dynamics of wetlands is key to maintaining their productivity and value as habitat for birds (Weller 1978).

Some wetlands have become choked with emergent vegetation, notably hybrid cattail (*Typha* x *glauca*). This phenomenon typically occurs in semipermanent wetlands surrounded by cropland, where grazing and other disturbances have been eliminated (Kantrud 1992). Although dense emergent stands afford nesting habitat for species such as common yellowthroat and marsh wren, they render the wetland less suitable for waterfowl and some other species. For that reason, managers try to reduce cattail stands to create a "hemimarsh" situation (Weller and Spatcher 1965), considered the ideal condition for dabbling ducks (Kaminski and Prince 1981). Several methods of cattail reduction have been attempted, but currently the favorite is the application of the herbicide glyphosate in a patchwork pattern (Linz *et al.* 1992). Natural forces sometimes still work; heavy precipitation in 1993 and 1994 flooded out cattails throughout much of North and South Dakota.

Where water levels can be controlled in wetlands, managers attempt to achieve several goals. One is to attract birds by applying water before they arrive in spring, but drawing it down later in summer or fall. This procedure simulates the natural dynamics of seasonal wetlands, and increases productivity of plants and invertebrates. Moist soil management (e.g., Reid *et al.* 1989) is a well-studied management practice designed to mimic

natural dynamics. Originally intended to benefit waterfowl, it enhances the value of habitat for breeding and migrating shorebirds and other wetland-dependent species as well (Fredrickson and Reid 1986).

CONSERVATION STRATEGIES

Wildlife conservation has advanced from managing habitats for maximum production of game species to a more encompassing—albeit less clearly defined—objective of protecting biodiversity. Meeting that goal will require action on many levels and scales, including local, regional, state, national, and international. A focus on neotropical migrants is appropriate, in the sense that those species face special risks and have received inadequate attention in the past. Other species are of concern as well and should not be neglected simply because they winter north of the U.S.-Mexico border. Ecologists have long argued about the artificiality of political borders to wildlife; programs such as Partners in Flight should be used to minimize barriers, not reinforce them.

We also must be clear about the meaning of biodiversity. Preserving diversity means protecting the various forms of life and the habitats and processes that support them (Keystone Center 1991). It does not mean maximizing local species diversity. Adding trees to a prairie landscape, for example, will increase local biodiversity by providing new habitat for such species as brown thrasher, gray catbird, song sparrow, common grackle, and western kingbird. But it will not enhance their viability, for these species are widespread, common, and can thrive independently of happenings on the prairie. Conversely, the addition of trees to grasslands may reduce the viability of true prairie birds, species whose future does depend on the grasslands (e.g., Knopf 1994).

Further, we should contrast management of prairie landscapes from that of cropland landscapes. Highly cultivated areas are generally depauperate of bird species, except certain "weedy" ones or those that favor sparse cover (Best *et al.* 1995). In such situations, adding trees and shrubs, and managing roadsides for wildlife will enhance the local species diversity and provide a more aesthetically pleasing environment without negatively affecting other species. In a true prairie situation, however, those same practices could be detrimental.

One promising development is the pairing of two major conservation partnerships, the North American Waterfowl Management Plan, whose goal is the restoration of waterfowl populations and habitats in North America, and the Partners In Flight program, which emphasizes neotropical migrant landbirds. The Waterfowl Management Plan works primarily through geographically based joint ventures. The Lower Mississippi Valley Joint Venture recently completed a habitat plan that encompasses neotropical migrant birds and shorebirds, as well as waterfowl. The Prairie Pothole Joint Venture has begun a similar effort. The initial emphasis will be to identify species of special concern, determine how management activities affect those species, and propose appropriate management strategies.

Unlike the situation with the Waterfowl Management Plan, defining population objectives for nongame species will be virtually impossible. Reasonable estimates of population size for those species are almost totally lacking. The BBS monitors trends in certain populations with some accuracy, but is imperfect for many others. Further, the often-low philopatry (McNicholl 1988) in many grassland and wetland birds argues against area-specific objectives. For example, Conservation Reserve Program fields in Eddy County, North Dakota, supported an average of only 0.03 pairs of Le Conte's Sparrows per 100 ha during 1991-1993. In 1994, because of extremely wet conditions, the density jumped to 21.47. Those conditions persisted into 1995, when the density continued to climb to 73.27 (unpubl. data). Other grassland and wetland species exhibit similar dynamic responses to precipitation, wetland conditions, temperature, and local land use such as burning and grazing. Establishing specific population objectives for particular habitats is not feasible; our approach should be to provide the habitat base that—when other environmental conditions are right—will support desired and sustainable populations.

SOME MANAGEMENT RECOMMENDATIONS

The following thoughts are offered regarding what could be done in the northern prairies to

enhance habitat for migratory birds. The proposed actions would be beneficial to a variety of other species as well, and would offer general conservation benefits.

Save the Sod.—Perhaps the highest priority is maintaining the base of native grassland that still remains. Several species of birds absolutely require this habitat. Most native grassland is privately owned, and much of it is excessively grazed. Nonetheless, even overgrazed prairie provides better habitat for grassland birds that does the alternative, cultivated fields. Although it would be worthwhile for agencies and conservation organizations to purchase native grasslands and manage them for their natural values, the total area that could be protected in this manner pales in comparison to the needs. Thus, migratory birds—and those who care about migratory birds—are dependent on privately owned ranches and farms. Maintaining range- and pasture lands is a conservation priority, and individuals and groups whose interests include birds should cooperate with ranching and farming advocates on issues of mutual benefit. Too often, the groups view one another as antagonists, rather than potential collaborators.

Grassland can be restored, but the full complement of forbs, vertebrate animals, invertebrates, and soil microorganisms cannot. It is far less costly to maintain a prairie than to reconstruct one. Further, existing grasslands often can be managed differently, in ways that improve the habitat they afford wildlife while still providing economic returns to the landowner. Biologists, range scientists, and the agricultural community should work together to develop and test land-use practices that offer economic benefits as well as wildlife and other conservation values. These practices might include rest-rotational grazing systems, minimum-till agriculture, and integrated pest management, among others.

Preserving wetlands will also benefit many species of migratory birds. In contrast to prairie, restoration of wetlands can be accomplished easier and with greater success. Wetlands have positive non-wildlife values, such as water retention to reduce downstream flooding, but also negative values, as impediments to agricultural operations, for example.

Target Farm Programs for Conservation Benefits.—Billions of dollars have been expended under past farm programs to balance supplies of commodities with demands and to maintain farm economies. Some of those programs also afforded conservation benefits, including protection from soil erosion and habitat for wildlife, but many did not. Although the current "Freedom to farm" plan appears to foretell the end of farm programs, it remains to be seen if that result will be realized. In any event, future farm programs could be developed to include conservation and wildlife benefits as high priorities. As one example, long-term rather than short-term set-asides not only permit cover to be planted that will benefit wildlife, they also help farmers plan with greater certainty about the future.

Manage What We Have.—Public lands, including national wildlife refuges, waterfowl production areas, national and state parks, national grasslands, and game management areas, are managed in various ways. Too often, little is known about the effects of those management practices on wildlife. Researchers and managers need to work together to learn about those effects. Researchers should not avoid management questions because they are "too applied," and managers should not avoid evaluating practices they apply because the research "costs too much and takes too long." The results of moving dirt are immediate; results of an evaluation are longer in coming, but may have more lasting value.

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