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Status and management of the greater prairie-chicken *Tympanuchus cupido pinnatus* in North America

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Greater prairie-chickens *Tympanuchus cupido pinnatus* are grouse of the tallgrass prairie of North America. Their range expanded greatly following the spread of early European agriculture into the grasslands and logging in forested areas. When the optimum mix of cropland and grass was exceeded, their range generally contracted to the regions where climatic and/or soil factors favoured the retention of grassland. Historically they probably occurred in 20 states of the United States and four Canadian provinces, but presently they only occur in 11 states and no longer in Canada. Their current status throughout the range varies considerably depending on habitat conditions, population levels, management capabilities and local land-use economic factors. A variety of conservation efforts, including translocation, are underway in the states where they occur, the intensity of which is generally inverse to numbers remaining. Noteworthy, is the Conservation Reserve Program (CRP) which has increased grassland cover on private land through incentive payments.

Key words: conservation, greater prairie-chicken, management, national status, Tympanuchus cupido pinnatus

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The greater prairie-chicken (GPCH) *Tympanuchus cupido pinnatus* occurred mainly in the tallgrass prairie of midwestern North America before the agricultural influence of European settlement. The presettlement center of distribution may have been near the common intersection point of the states of Missouri, Illinois and Iowa (Fig. 1). As early agriculture moved north and west, GPCH spread as well and occurred (at different times from the 1800s to the present) over an extensive area of North America, including the mixed-grass prairie of the West. Logging and wetland drainage, followed by burning and cultivation, even allowed birds to move north into previously forested or wet areas of Minnesota, Wisconsin, Michigan and Ontario, Canada. The numbers of GPCH were legendary in different parts of the range and subsistence as well as market hunting was typical (Hier 1999). Prairie-chickens thrived when cropland was 20-30% of the grassland landscape, but declined when the cropland proportion exceeded that. In previously forested areas, birds generally retreated southward as woody vegetation reclaimed former cropland due to natural succession and tree planting. The maximum

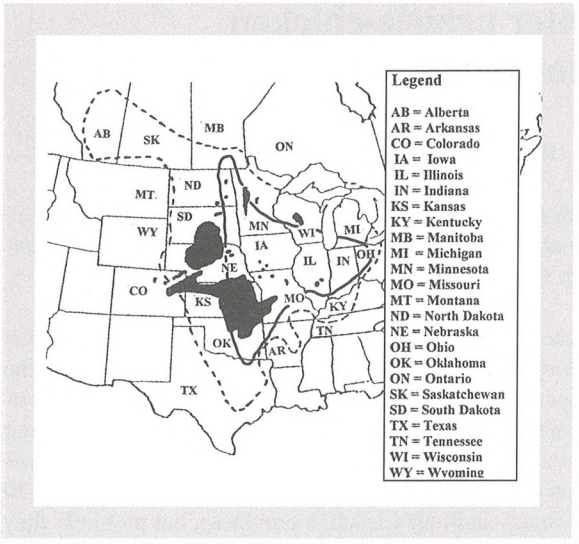

Figure 1. Distribution of the greater prairie-chicken in North America in the past (dashed line; adapted from Schroeder & Robb 1993) and at present (solid areas; adapted from Westemeier & Gough 1999). The solid line delineates the approximate presettlement boundary of the tallgrass portion of the prairie biome (adapted from various sources).

range expansion and even the current distribution of GPCH is a tribute to the ability of the bird to adapt to a wide range of climatic, soil and vegetation types.

This paper reviews the status of GPCH in the states where they presently occur as to 1) their history, 2) principal factors affecting their spread and/or decline, and 3) current populations, and makes recommendations that may help reverse population declines. Population data for the last 30 years were obtained from literature reports and a questionnaire sent to wildlife managers and researchers familiar with each state.

Status review by state

There is a great variety of climatic, soil, vegetation, historical, land-use and economic factors throughout the current range of the GPCH. It is instructive to review this spectrum to appreciate effects of physical and land-use factors as they influence different approaches needed for the conservation of the species under local and regional conditions. Important throughout most of the current range is the Conservation Reserve Program (CRP) funded by the U.S. government. The aim is to remove erosion-prone croplands from annual production by paying landowners to convert them to permanent vegetative cover (generally grass in the Plains States) providing soil protection, water quality enhancement and wildlife habitat that will be undisturbed for either a 10 or 15-year contractual period. Often, cropland that is eligible for the CRP is located near remnant grasslands supporting GPCH.

Colorado

The presettlement vegetation of the Colorado GPCH range was short-grass prairie or steppe and GPCH likely did not occur there until some grasslands were converted to small grain (wheat *Triticum aestivum*, barley *Hordeum vulgare*, oats *Avena sativum*) agriculture in the late 1890s (Giesen & Schroeder 1999). Populations peaked in the early 1900s and then declined low enough in the 1970s to be classified as state endangered. Seeding of warm-season grasses (particularly *Andropogon spp., Calamovilfa longifolia, Sorgastrum nutans, Panicum virginicum, Sporobolus cryptandrus* and *Eragrostis trichodes*), prescribed burning, translocations and expansion of grasslands on private lands under the

Table 1. Most liberal estimates of abundance of greater prairie-chickens in the United States during 1968-1997.

State	1968[a]	1979[b]	1985[c]	1989[d]	1997
Unhunted populations					
Colorado	760	3,000	6,000	8,000	10,000
Minnesota	5,000	2,000	1,600	2,000	1,868
Wisconsin	1,000	1,842	1,354	1,200	1,222
Missouri	10,000	9,600	6,000	3,000	1,000
North Dakota	1,800	1,000	800	?	300
Iowa	0	0	0	?	200
Illinois	300	230	300	68	168
Hunted populations					
Kansas	450,000[e]	880,000[e]	540,000[e]	530,000[e]	160,000[e]
Nebraska	100,000	200,000	200,000	200,000	131,484[f]
South Dakota	80,000	40,000	?	?	65,000
Oklahoma	130,000	80,000	?	12,000	1,500

[a] Based on Christisen (1969; estimate for Colorado amended).
[b] Based on Westemeier (1980).
[c] Based on Westemeier & Edwards (1987; Colorado estimate for 1983 from Van Sant & Braun (1990)).
[d] Based on Gough (1990).
[e] Estimates for Kansas are based on the assumption that the harvest estimates reported by Applegate & Horak (1999) are 10% of total population.
[f] Estimate for Sandhills only.

CRP resulted in a remarkable 10-fold increase in the last 30 years (Table 1). The species is no longer considered as state threatened or state endangered. Grazing is the predominant land use on private lands within the GPCH range with >30% estimated to be of 'good quality', (K. Giesen, pers. comm.). Giesen also notes that eight of the last 10 years (1989-1998) had 12.7% above average rainfall which he believes "has had a major impact on the increasing prairie chickens".

Minnesota

The western third of Minnesota was tallgrass prairie in presettlement times, and GPCH were thought to have occurred only along the extreme southern edge (Svedarsky, Wolfe & Toepfer 1997). As in most northern states, they expanded their range greatly to the north as grain farming increased but declined as the optimum mix of grass and cultivated land was changed to favour cropland. Populations were eventually restricted to mainly northwest Minnesota where sandy soils prone to drought and containing rocks made it difficult to cultivate privately owned prairies. Increased grassland acquisition and management by governmental (state and federal) conservation organizations and the privately-funded, The Nature Conservancy (TNC), and enrollment of extensive amounts of land in CRP within the GPCH range have resulted in generally stable numbers in the last 30 years (see Table 1). Management (prescribed burning, mowing and grazing) to control brush encroachment, maintain prairie vigour, and reduce litter (dead, residual vegetation) is a continuing imperative on public as well as private lands enrolled in CRP. Recent (in the 1990s) wet years have hampered management efforts.

Wisconsin

Wisconsin GPCH populations exist on grasslands that are somewhat similar to those in Minnesota with respect to brush encroachment challenges. A notable difference, however, is that Wisconsin populations occur almost entirely on lands that were originally forested in the central part of the state and are absent from their original prairie range to the south (Anderson & Toepfer 1999). Land acquisition by the state Department of Natural Resources and the private, Dane Conservation League and the Society of Tympanuchus Cupido Pinnatus, has been specifically targeted for GPCH. These have been actively managed for the last 50 years, stimulated by the pioneering management research efforts of Fred and Fran Hamerstrom (Hamerstrom & Hamerstrom 1973). The Hamerstrom plan (Hamerstrom, Mattson & Hamerstrom 1957) of 'ecological scatter-pattern' was to provide grassland reserves throughout the mosaic of private land uses and is still followed. Wisconsin GPCH management is very intensive and GPCH numbers have been relatively stable in recent years (see Table 1).

Missouri

Presettlement Missouri contained a mixture of tallgrass prairie and deciduous forest fingers associated with streams, generally in the northern and western two-thirds of the state (Mechlin, Cannon & Christisen 1999). Perhaps a million or more GPCH occupied these grasslands during the 1860s when 23-30% of the prairie had been converted to crops. Land use intensified much beyond the optimum mix, however, and GPCH are now classed as state endangered. More than 80% of the GPCH populations are associated with the 1% of the remaining native prairie (Mechlin et al. 1999). Habitat fragmentation (accentuated by tree and shrub growth along fence rows), widespread planting and heavy grazing use of exotic cool-season fescue grass *Festuca elatior*, and double-cropping (wheat followed by soybeans *Glycine max* in the same year) leaving little winter food resources, have been identified as key conservation issues. While management of the remaining native prairie is critical, expansion of management to private lands is important as well if the GPCH declines of the recent 30 years (see Table 1) are to be halted. Current trends suggest the possible extinction of GPCH in the state by 2009.

North Dakota

Originally GPCH occurred south of the state and spread north and west with agriculture until they occupied most of the state except the Badlands in the southwest corner (Kobriger 1999). From extensive numbers in the early 1900s, GPCH are now mostly restricted to a sandy deltaic habitat island (surrounded by cropland) of tallgrass prairie and oak/aspen *Quercus macrocarpa/Populus tremuloides* woodlands in southeastern North Dakota, known as the Sheyenne National Grasslands, where approximately 100 males were spring-censused in 1996 (Svedarsky & Van Amburg 1996). The prospects for long-term GPCH survival are not good in this area because of reduced grass cover as a result of cattle grazing. Also, leafy spurge *Euphorbia esula*, an unpalatable exotic weed, covers about 20% of the grasslands thereby causing the remaining 80% to be grazed more intensively if cattle numbers are not appropriately adjusted. Sharp-tailed grouse (STGR) *Tympanuchus phasianel-*

lus have recently increased in the area as GPCH have declined. GPCH may have decreased due to a negative interaction between the two species, an increase in woody species such as *Salix* spp., *Symphoricarpos occidentalis, Populus tremuloides* reflected by STGR numbers, or a combination (Svedarsky & Van Amburg 1996). Recent (1992-1998) GPCH translocations to northeastern North Dakota have shown initial success (Kobriger 1999).

Iowa

Iowa was much like presettlement Missouri with tallgrass prairie inter-digitating with forests along streams. GPCH probably nested over the entire state (Moe 1999). Moe suggested that the optimum land-use mix for GPCH occurred around 1880, but the increasing intensity of land use caused the extirpation of GPCH by the early 1950s. Unbroken native prairie is now extremely rare but several prairie restoration efforts are underway. Increased CRP areas planted to wildlife-friendly (forbs and warm-season grass) mixtures and improved rotational grazing systems are creating better habitat for GPCH. The improved habitat conditions set the stage for translocation attempts which showed modest success by 1998 in southern Iowa near remnant populations of north Missouri. The plan is to provide public-owned core areas of optimum habitat complemented by adjacent areas of private land with habitat values.

Illinois

Known as the 'Prairie State', Illinois was originally >60% tallgrass prairie and supported possibly several million GPCH (Westemeier, Brawn, Simpson, Esker, Jansen, Walk, Kershner, Bouzat & Paige 1998a). Fertile land promoted intensive agricultural utilization and, by 1978, <0.01% of the original prairie remained (White 1978). GPCH had declined to 2,000 by 1962 and to only 24 displaying males (probably <50 total GPCH) by 1994. Westemeier and co-workers documented that both fitness, as measured by fertility and hatching rates of eggs, and genetic diversity declined correspondingly with the population (Westemeier et al. 1998a). Between August 1992 and April 1998, 518 GPCH were translocated to Illinois from Minnesota, Kansas and Nebraska. This was drastic action, but at least in the short term, it has rescued the population from extinction, demographically and genetically. Intensive habitat management using mainly cool-season exotic grasses such as redtop *Agrostis stolonifera* and timothy *Phleum pratense* harvested for seed has been successfully practised for many years on private land and Illinois sanctuaries, but grasslands became too limited and apparently could not counter effects of low population size. Toepfer, Eng & Anderson (1990: 595) suggested that "200 birds or 100 displaying cocks" are needed for "minimum viable populations" of GPCH based on historical records of declining populations, which became extirpated. Nest parasitism and lek disruption by ring-necked pheasants (RNPH) *Phasianus colchicus* have also negatively impacted GPCH in Illinois (Westemeier, Buhnerkempe, Edwards, Brawn & Simpson 1998b).

Kansas

Historical records suggest that GPCH occurred mainly in eastern Kansas, primarily in tallgrass prairie, and spread westward into mixed and shortgrass prairie with the spread of agriculture (Applegate & Horak 1999). Peak numbers occurred in the 1880s but declined, as elsewhere, when the mix of grassland and cropland became unfavourable. The drought of the 1930s was detrimental to GPCH populations due to direct effects of cover reduction and indirect effects associated with severe overgrazing. The Flint Hills region of eastern Kansas has been the key GPCH area in Kansas. Shallow soils overlying bedrock discouraged cultivation and promoted livestock ranching which is generally compatible with GPCH habitat needs. However, recent economic pressures and ranching practices are adversely affecting critical nesting and brood-rearing habitats. Season-long (May-October) and less intensive grazing systems have been replaced by early May - mid July systems at twice the stocking rate of cattle (Applegate & Horak 1999). This is commonly preceded by annual prescribed burning in March and April to control woody plant invasion and increase forage production and palatability for livestock. Rangeland burning every 3-5 years is beneficial for GPCH in Kansas tallgrass prairie, but annual burning removes residual vegetation needed by nesting GPCH and probably decreases their productivity. Woody plant invasion, conversion of grassland to other uses, and possible increases in predation rates have also negatively impacted GPCH populations. Although GPCH are still hunted in significant numbers in Kansas, overall population trends are down based on lek surveys and harvest estimates (Applegate & Horak 1999).

Nebraska

Similar to Kansas, GPCH were historically found mainly in the eastern part of the state and expanded westward with homesteading and development of crops

within the prairie landscape commencing in the 1860s (Vodehnal 1999). North central Nebraska contains one of the largest (~50,000 km^2) sand-dune areas (the 'Sandhills') in the Western Hemisphere and this became the primary GPCH range as settlers replaced the grasslands with cropland in the eastern portion of the state. Sandy soils of the Sandhills favoured grazing as a predominate land use with cultivated crops in the lowlands. An all-time GPCH population low came in 1937 as a result of the great drought and associated overgrazing. Better grazing practices, advocated by the Soil Conservation Service of the U.S. government, brought better grassland cover and GPCH rebounded until the expansion of center-pivot irrigation in the 1960s. Some irrigated cropland among grasslands was beneficial to GPCH and other wildlife, but the optimum mix was surpassed. By 1978, 214,000 ha were irrigated in the Sandhills with 85% of this occurring in the primary GPCH range (Vodehnal 1999). Some of these irrigated areas were converted back to grasslands in 1985 under CRP contracts and high numbers of GPCH were reported in 1987. The current GPCH range consists of tall and mixed prairie grasses intermixed with cropland, primarily corn *Zea mays*. GPCH are a popular game bird in the eastern Sandhills along with STGR. GPCH populations are generally secure, but are vulnerable to economic factors affecting livestock ranching which may negatively impact residual nesting cover. Delaying grazing until after the nesting peak is recommended along with rotational rest periods that ensure adequate nesting cover be available in early spring.

South Dakota

GPCH were most numerous in presettlement times in eastern South Dakota and expanded westward with agriculture (Fredrickson, Crouch & Heismeyer 1999). As land use intensified, the population became concentrated in the south-central part of the state, particularly on the Fort Pierre National Grasslands (FPNG). Numbers have increased in recent years on the FPNG in apparent response to reduced grazing and the implementation of a rest period. Populations have also increased due to more cropland being placed in CRP and increased precipitation which promotes vegetation growth serving as nesting and brood cover. The increased forage growth may also reduce grazing pressure on GPCH cover so long as cattle stocking rates are not increased proportionately. Drought generally results in low GPCH reproduction in South Dakota (Fredrickson et al. 1999) since cover is a key limiting factor. A fairly strong hunting tradition of GPCH and STGR is popular in localized areas and this helps to maintain a level of public interest.

Oklahoma

From an original distribution in the eastern two-thirds of the state, the current GPCH population is centered mainly in the northeastern part where shallow soils overlying limestone and sandstone promote grassland retention and discourage cultivation (Horton & Wolfe 1999). This is a southern extension of the Flint Hills region of Kansas. Similar to Kansas, a recent shift to large-scale spring burning followed by intensive grazing has greatly reduced GPCH nesting and brood-rearing habitat. The most recent hunting season was in 1997, but low harvest numbers (<200 birds) prompted a closure of the season until at least 2002.

Translocations

During 1970-1990, there were 26 GPCH translocations in North America, most of which were unsuccessful (Toepfer, Eng & Anderson 1990). More recently, translocation projects have been carried out in Iowa, Missouri, Illinois, North Dakota, Colorado and Minnesota with most conducted during the breeding season. The evidence to date from experience in North Dakota, Minnesota, Wisconsin, and Illinois is that generally <50% of birds released during the breeding season remain near the release site; others commonly moved 40-140 km (J.E. Toepfer, unpubl. data). One radio-marked hen near Crex Meadows, Wisconsin, moved 101.4 km in three days and it was not uncommon for hens to move 16 km per day for several days (Toepfer 1988).

Resident birds, especially immatures, may also move considerably during this time and thus complicate translocation efforts. Nonetheless, Toepfer has found that trapping birds on leks (in the spring when they are easy to catch), radio-marking them, releasing in place, and then retrapping and moving them when in molt during July and August, greatly reduces movements upon release. Typically, summer-moved birds tend to establish themselves closer to the release site than birds released in spring. Commencing in 1992, Toepfer has used this technique to establish a 'population' in northeastern North Dakota which totalled 174 cocks on 19 leks in 2000; 16 of these leks were within 3.2 km of the release site. We believe the major obstacle to translocating GPCH in North America will be finding grassland habitat without RNPH and STGR. Both can be

quite aggressive towards GPCH, STGR are more adaptable to grazing and severe winters than GPCH, and RNPH may parasitize GPCH nests and possibly increase losses due to mistaken identity if RNPH hunting is allowed in an area with GPCH.

Summary and conservation needs

The history and present status of GPCH in North America varies widely from state to state due to climatic and soil differences as they affect land-use practices. Illinois populations are probably the most endangered because of their small size, isolation and lack of enough supporting grasslands (see Table 1). Iowa and North Dakota populations are similar in size to Illinois flocks, but are closer to populations of other states (see Fig. 1) which gives them more potential for interchange. Current downward trends appear most serious in Missouri, Oklahoma, North Dakota and possibly even Kansas. Relative stability seems to exist in Nebraska, South Dakota, Minnesota and Wisconsin. The steady upswing in Colorado portends a bright outlook for GPCH in that state; however, since most birds occur on private land, Colorado GPCH could be in jeopardy if land-use changes follow those of Kansas and Oklahoma.

Increasingly fragmented populations set the stage for numbers to fall below some critical threshold, perhaps 100 spring males, needed for species survival (the tentative number of 100 spring males assumes an adequate number of females as well. This may not be the case if a declining population becomes male-biased and this question needs further definitive research). Birds using fragmented grasslands (due to increasing woody plant invasion and conversion of adjacent lands to cropland) may experience increased predation rates compared to more expansive habitats. We recommend that approximately 30% of the grassland within a 1.6-km radius surrounding leks provide spring nesting cover with a Visual Obstruction Readings (Robel, Briggs, Dayton & Hulbert 1970) of 2.0 dm and be accessible to brood cover in order to maintain GPCH populations. In the western parts of the GPCH range, this minimal cover reading is commonly lacking as a result of heavy grazing, often preceded by extensive spring burning to control woody plants and improve forage value and utilization to livestock. 'Good' range management may be good for livestock production but is often detrimental to prairie grouse. Precipitation is commonly limiting to GPCH cover in the western part of the range, but may be excessive in the eastern range, particularly if it occurs during the brooding season. Also, this excessive precipitation may accelerate woody plant invasion and hamper management efforts. In the eastern range, cover must be managed by rotational burning, mowing, seed-harvesting or grazing to maintain grassland vigour and reduce woody plant invasion and excessive litter buildup (McKee, Ryan & Mechlin 1998). This is true for native grasslands as well as planted CRP land. A portion of the landscape (perhaps 25%) in cropland is important throughout the range of the GPCH, but especially in more northerly areas where winter food may be limiting due to excessive snow cover.

Accurate censusing techniques must be developed and implemented range-wide to measure effectiveness of management actions. Population numbers should be monitored intensively to detect when 'rescue' efforts by translocating birds may be necessary. Translocations are recommended only for areas where adequate habitat is available, and factors that caused the population decline have been corrected. The primary goal of translocations would be to expand existing populations rather than establish isolated populations subject to inbreeding.

Greater prairie-chickens are birds of the prairie biome of North America, particularly the eastern portion originally supporting tallgrass prairie (see Fig. 1). Since the most fertile soils of the continent were developed by this tallgrass ecosystem, most of the tallgrass (>99% of the presettlement amount) has been converted to intensive cropland unless deterred by geologic circumstances (sandy or shallow soils, steep slopes, rocks). Because GPCH require a fairly substantial amount of grassland, the opportunities to conserve them in the tallgrass region, i.e. Missouri, Minnesota, Wisconsin, Illinois, Iowa and the eastern parts of Kansas, Oklahoma and Nebraska, are perhaps limited largely to those areas where they presently occur due to the economic constraints of valuable cropland. Conservation opportunities are perhaps better in the western, mixed-grass portion of the GPCH range where lower precipitation better favours the retention of grassland on the landscape. Increasingly, the presence of GPCH is viewed by the public as a symbol, or indicator of sorts, that a prairie unit is a 'complete' system. This interest, along with promoting their aesthetic and hunting values, where appropriate, can be expanded and maintained to build public support for greater prairie-chicken conservation programs.

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