THE GREATER PRAIRIE CHICKEN IN MINNESOTA

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HISTORICAL REVIEW

Distribution

Reports are unclear as to the presettlement distribution of the greater prairie-chicken (*Tympanuchus cupido pinnatus*) in Minnesota but Partch (1973) reviewed early records which suggested its presence along the southern edge of the state in the early 1800's (Fig.1). Hatch (1892) recalled conversations with Chaplain Gear at Fort Snelling (now the site of the Twin Cities) in about 1839: "He stated that the prairie hens (chickens) were seldom seen at the first, but after the country began to become settled considerably, they increased in numbers perceptibly from year to year." As agriculture moved northward onto the prairies, so did prairie chickens at the rate of about 16 km a year (Partch 1973). By 1880, prairie chickens had reached extreme northwest Minnesota and had also moved a considerable distance into the forested part of northeastern Minnesota as logging, land clearing, and recurrent fires created "grasslands." The maximum extent of the range was probably reached around 1900 when prairie chickens occurred over most of the state where suitable grassland habitat was present (Fig. 1).

Two factors - intensified agriculture and plant succession - were responsible for a steady reduction in prairie chicken range after 1900. Concurrent with maximum range expansion to the north, a decline in chicken numbers was commencing in the southern counties due to intensified agriculture. Greater mechanization facilitated large-scale drainage, cleaner farming (especially the shift from threshing machines and straw stacks to combines), and the consolidation of the patchwork of pastures, wild hayfields, croplands, undisturbed grasslands, and wetlands into larger fields. This trend moved northward and by the 1960's prairie chickens were found primarily in northwest Minnesota along the beach ridges of glacial Lake Agassiz (Erickson and Farmes 1960). The droughty nature of the beach ridge soils and the presence of large rocks made it uneconomical to cultivate much of the grasslands and they were used for wild hay production, grazing, or left idle. Prairie chickens declined in the forested part of the state as "created grasslands" were lost to natural plant succession and tree planting. A key factor in this change was fire suppression. To an extent, this was necessary to safeguard tree plantations, human lives, and property, but it greatly hastened plant succession.

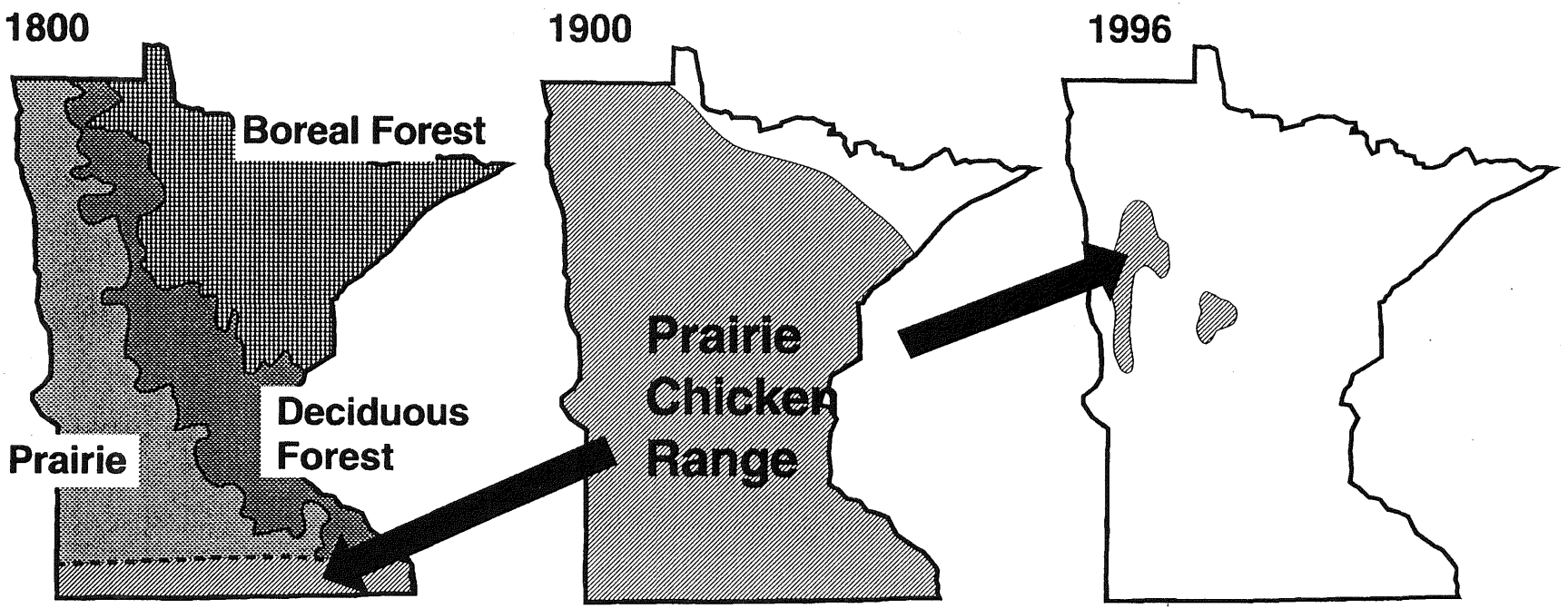

Fig. 1. Presettlement vegetation & approximate prairie chicken range in Minnesota at selected dates.

In the early 1970's, high grain prices coupled with relatively low prices for prairie land ($250-370 per hectare) stimulated increased conversion of native prairie and other idle lands to croplands throughout the range in northwest Minnesota (Fig. 1). This increased grassland habitat loss was slowed by declining grain prices in the early 1980's and the enactment of the 1985 Farm Bill with its "sodbuster" and "swampbuster" provisions, penalizing landowners for converting grasslands (if occurring on highly erodible soils) and wetlands to commodity crop production. Also, many fields with highly erodible soils were enrolled in the Conservation Reserve Program (CRP) of the Farm Bill and planted to cover crops for a 10-year contractual period.

A small remnant population of prairie chickens also persists in the largely forested north central part of the state (Fig. 1) where a combination of factors are maintaining scattered grasslands. Soils and climatic factors favor forest vegetation but grassy lowlands are periodically burned by private individuals to retard brush invasion and allow harvesting of wild hay. Sandy soils predominate on upland sites and support fire-prone jack pine (*Pinus banksiana*) savannas which are periodically burned by wild fires and temporarily provide prairie chicken habitat for 4-5 years thereafter (Svedarsky et al. 1982).

Density

The number of prairie chickens in the early years can only be inferred as "abundant" based on accounts of the numbers shot. Swanson (1940) indicated that it was not uncommon for a single hunter to bag 100 birds a day in the late 1800's. According to Paterson (1973), hunters typically shot a wagon box of chickens during a day's hunt in the late 1800's and early 1900's. Harvest data collected by the Minnesota Department of Natural Resources (MN DNR) from 1921-1950 indicated a peak harvest of 328,914 in 1923, falling to a low of 10,547 in 1929, and then rising to 58,000 in 1942, the last prairie chicken hunting season in the state (Table 1). Interestingly the season remained open during the early '30s, when harvests were low, but was closed when populations were apparently higher.

The first prairie chicken censusing was carried out in Minnesota by C. Edward Carlson and Vince Reid in the late 1930's and early 1940's (R.E. Farmes, MN DNR, *pers. commun.*). Erickson and Petraborg (1952) reported the earliest attempts to systematically census prairie chickens was in Norman County in 1941 and 1942 when 13 booming grounds with an average of 11 males per ground were counted each year. They also noted that 399 rural mail carriers recorded prairie grouse along mail routes in northern Minnesota. In March of 1946, 1 prairie chicken was observed per 328 km traveled and 1 sharp-tailed grouse (*Tympanuchus phasianellus*) per 214 km. In 1947, the same number of prairie chickens were recorded but nearly 3 times as many sharp-tailed grouse were seen. Based on these mail carrier questionnaires, populations were best in Kittson, Marshall, Pennington, Polk, Red Lake and Roseau Counties in those years. Farmes and others later conducted census routes near Thief River Falls in northwest Minnesota from 1951 to 1956 and in 1964 and 1965. The number of booming grounds was recorded but the number of birds present on grounds was "vague"

Table 1. Calculated harvest of prairie chickens and sharp-tailed grouse in Minnesota, 1921-1950. (Adapted from, Erickson and Petraborg, 1952).

Year	Prairie chicken	Sharp-tailed grouse	Year	Prairie chicken	Sharp-tailed grouse
1921	176,637	-	1934	25,444	13,310
1923	328,914	14,409	1935	36,498	6,822
1924	Closed	15,849	1940	125,000[a]	-
1925	411,971[a]	-	1941	135,000[a]	-
1927	103,929[a]	-	1942	58,000	42,100
1929	10,547[a]	-	1948	Closed	13,687
1931	14,125[a]	-	1949	Closed	153,637
1933	29,216	8,084	1950	Closed	82,726

[a] Kill not broken down by species - includes both prairie chickens and sharp-tailed grouse.

(Paterson 1973). Preliminary censusing of the primary range (excluding the north central portion) was made in 1971 and 1972 when 41 booming grounds were located with an average of 16 birds (sexes not separated) per ground. Annual censuses coordinated by the Minnesota Prairie Chicken Society (MPCS) began in 1974 in the northwest and 1977 in the north central range. Chicken numbers have fluctuated in recent years, with highs of 1648 and 1913 spring males in 1982 and 1992, respectively (Fig. 2). Swanson (1940) summarized prairie chicken abundance periods for the late 1800's from newspapers and sportsman accounts. Mid-points of these periods were 1863, 1871, 1880-81, and 1894-95, suggesting that historic peaks occurred in years ending in 1, 2 or 3. Hamerstrom and Hamerstrom (1973) found peaks occurred in their Plainfield, Wisconsin study area in 1940, 1950, and again in 1970 and 1971.

To some extent, census data reflect yearly variations in access conditions, censusing weather, and turnover of personnel but we believe they are reasonable estimates of minimum numbers and general population trends. The statewide counts parallel ($r=0.92$) those in a Polk County study area near Crookston which has been intensively censused since 1974. The approximate spring density in that study area ranged from about 1 male per 2.6 km^2 (section) or 1 per 25 ha of preserved habitat during low years to over 2 males per the same area during the high population years of 1982 and 1992 (Fig. 2).

The number of booming grounds per year tended to vary more than the average number of males per ground (Fig. 3) and was more correlated with the total number of males censused ($r=0.90$ vs. $r=0.61$). The mean number of males per booming ground for the 19-year period was 10.1 (s.d. $=1.9$) with a high of 75 recorded on a ground in Clay County in 1992 (Brian Winter, TNC, *pers. commun.*)

Habitat Acquisition Programs

As land use intensified on private lands with the attendant reduction of habitat values, there was a need for conservation agencies to purchase and manage lands as wildlife habitat. In 1951, the "Save the Wetlands" program of the MN DNR was launched, and by 1973 there were 9,760 ha of state wildlife management areas in the northwest prairie chicken range (Nielsen 1973); these totaled 15,998 ha by 1996 (Table 2). In 1961, the U.S. Fish and Wildlife Service (USFWS) initiated the wetland acquisition/easement program in western Minnesota and the Dakotas. This program and the Hamden Slough National Wildlife Refuge totaled 12,868 ha of waterfowl production and refuge areas in the northwest chicken range by 1996. While these programs were directed primarily towards the protection of wetlands within the "prairie pothole country", approximately 60% of the units was grassland habitat useful to prairie chickens and other wildlife. The Nature Conservancy (TNC) began purchasing land of natural uniqueness in the late 1960's and, encouraged by the emphasis placed on the prairie chicken at a conference held at Crookston in 1973, launched the "Minnesota Prairie Chicken Preserve System" in 1974. By 1996, MN DNR, USFWS, and TNC had acquired 32,769 ha

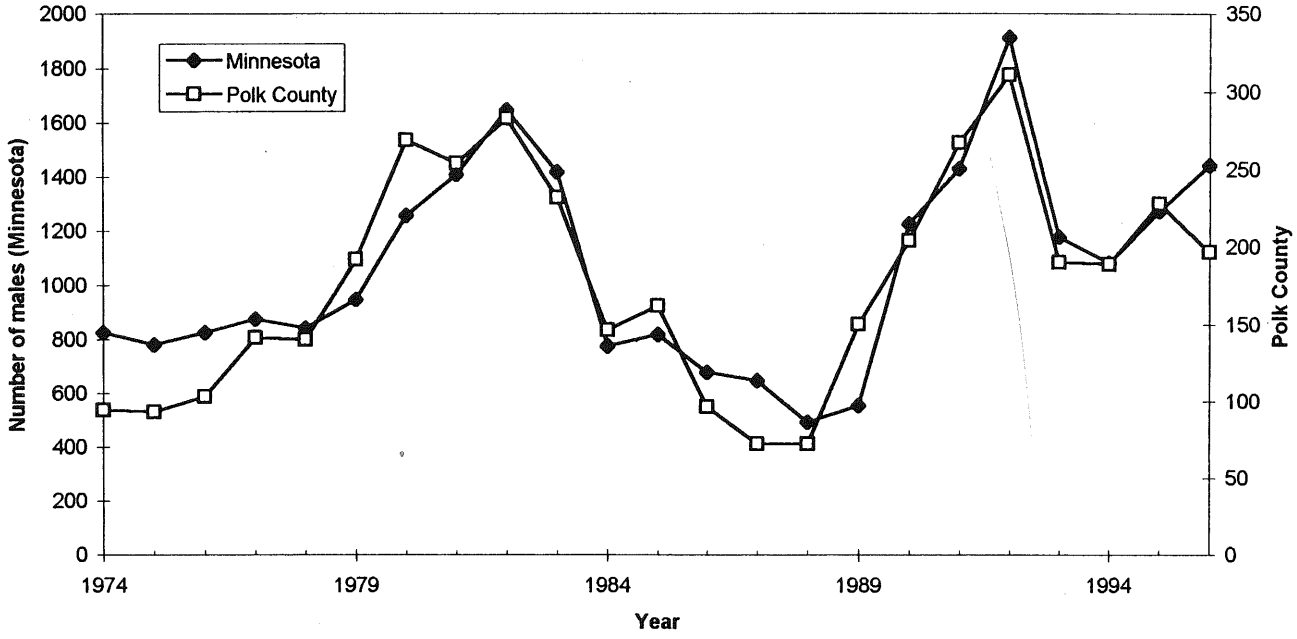

Fig. 2. Spring estimates of male greater prairie-chickens in Minnesota and Polk County, 1974-96.

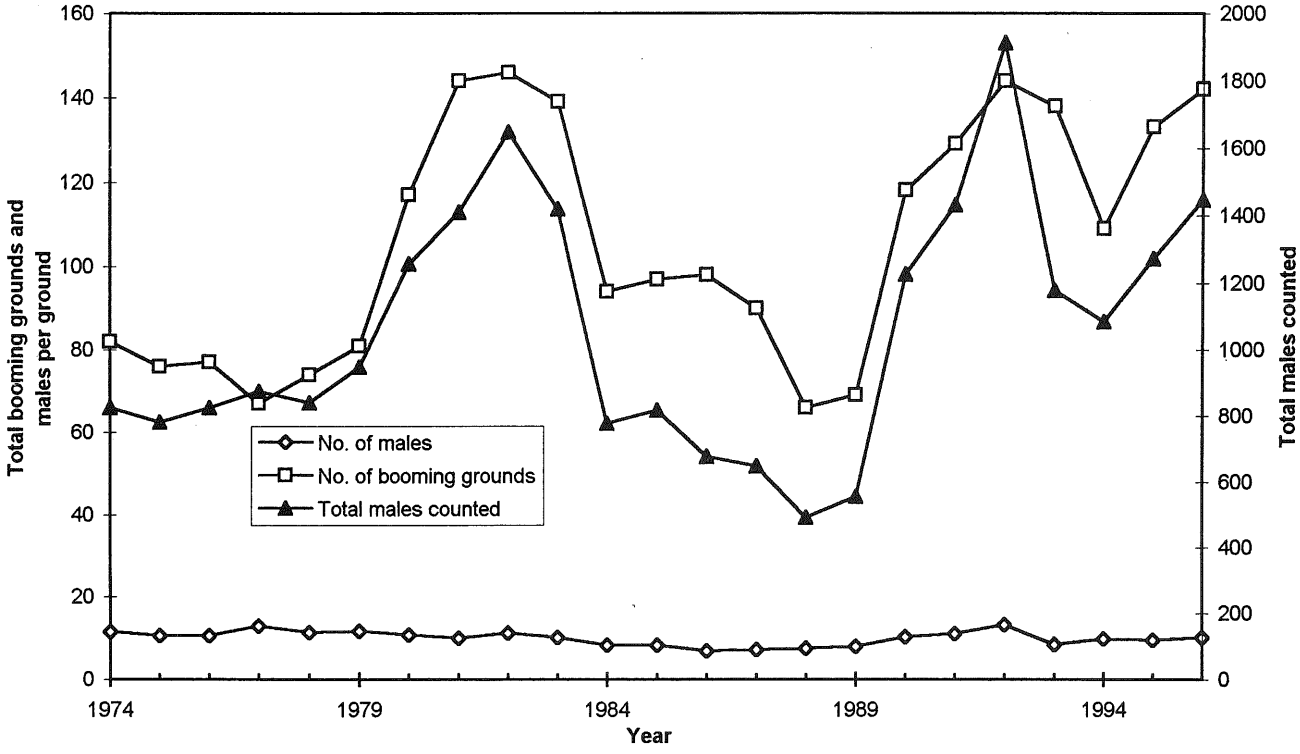

Fig. 3 Total prairie chicken booming grounds and mean numbers of males per ground in relation to total males counted statewide, 1974-96.

Table 2. Grassland habitat (hectares) within the northwest Minnesota prairie chicken range by ownership in 1973, 1983, and 1996.

Ownership	Year[1] 1973[2]	1983	1996
Minnesota Department of Natural Resources	9,760	12,600	15,998
U.S. Fish and Wildlife Service	2,760	5,800	12,868
The Nature Conservancy	424	2,300	3,903
Conservation Reserve Program	0	0	60,000[3]
Total	12,944	20,700	92,769

[1]Some area increases between time periods may reflect prairie chicken range expansion on to previously acquired lands as well as additional purchases within the range.

[2]From Nielsen 1973.

[3]Estimate based on enrollment contracts as of 7 July 1989.

of habitat in the northwest chicken range and continue to do so but at a slower rate. These lands are complemented by approximately 60,000 ha of erosion-prone lands which are in grass cover under the Conservation Reserve Program.

About 21% of the land within the north central range (Fig. 1) is public (county or state). Most is presently managed as forest land, but 200 ha of brushland were recently (1990-1993) converted to grassland and 800 ha were acquired for prairie grouse (Rob Naplin, MN DNR, *pers. commun.*). The future of this prairie chicken population is closely tied to private land use practices unless more public lands are designated as prairie chicken management units.

Reintroduction Projects

Minnesota has been involved in 4 prairie chicken reintroduction projects. In 1977, 29 birds were trapped in western Minnesota during spring and summer and released at the Crex Meadows Wildlife Area in northwestern Wisconsin to supplement earlier releases of pen-reared and wild birds from central Wisconsin. Three releases of pen-reared prairie-chickens from the MN DNR Carlos Avery Game Farm were made from 1977-1980 at the Lac Qui Parle Wildlife Management Area in extreme west central Minnesota (Arlin Anderson, MN DNR, *pers. commun.*). Birds were released in September of 1977 (n=35), 1979 (n=24), and 1980 (n=35) in an area containing good upland cover and planted food plots. Birds were leg-banded but not radio-tagged so their fate is unknown. In 1983, no booming cocks were reported but some birds were observed during the summer (Rick Johnson, TNC, *pers. commun.*). Possible reasons for the Lac Qui Parle failure are: 1) the use of pen-reared rather than wild birds, 2) releases during the fall raptor migration, and 3) the presence of ring-necked pheasants (*Phasianus colchicus*) in the area.

In 1983, Minnesota became involved in a reintroduction project with North Dakota. The goal was to substitute Minnesota prairie chicken eggs for sharp-tailed grouse eggs in nests located on or near the Arrowwood National Wildlife Refuge in east central North Dakota. Due to difficulty in locating chicken nests, additional eggs were provided by Clifford Steinhauer, a private propagator in Holt, Minnesota. This project was unsuccessful.

In April, 1992, a reintroduction project directed by Toepfer was initiated with the North Dakota Game and Fish Department. In this effort, birds were captured on Minnesota booming grounds, radio-marked and then retrapped and translocated during summer to extreme east central North Dakota near Manvel within the Kelly's Slough Wildlife Management Project. Twenty-nine birds (12 cocks and 17 hens) were translocated in 1992, 25 (14 cocks and 11 hens) in 1993, and no birds in 1994. In the summer of 1995, a booming ground of 14 cocks was supplemented with the release of 49 Minnesota birds (25 cocks, 19 hens, 5 unknown sex), including 2 brood hens with 3 chicks each. Beringer (1995) summarized the results of the North Dakota translocation project for the period 1992-95. In 1996, 32 cocks were translocated from Minnesota to North Dakota; 2 in mid-April, 2 in early

June and 28 during July and August. Fifteen of these birds were released near known booming grounds to supplement existing numbers. The rest were released at new sites to establish new grounds.

During the North Dakota project, birds were also translocated from Minnesota to Illinois to increase the genetic diversity in a population which had dwindled to about 40 birds. In 1992, 15 birds (all hens) were moved and 12 (6 cocks and 6 hens) in 1993. The birds translocated to Illinois included a radioed hen and her 2, 4-week old male chicks.

Both the Illinois and North Dakota translocation efforts yielded positive results. The Illinois population has increased as has the egg hatchability rate (Ron Westemeier, *pers. commun.*). Low egg hatchability is a possible sign of inbreeding. In North Dakota during April 1996, 5 booming grounds totaling 23 cocks were located within an 8-km radius of the original 1992 release site. Two grounds had 7 and 9 cocks and several smaller grounds had 2-3 cocks. All booming grounds were within 1.6 km of a previous year's release.

The release of cocks translocated during the July and August molt appears to be a reliable way to hold translocated prairie chickens near the release site and establish booming grounds nearby. Movements are generally reduced at this time and food resources are plentiful (Toepfer, et al. 1990).

Future plans involve supplementing the existing Manvel, North Dakota population with an additional 100 birds (50 cocks and 50 hens) in 1997 and 1998. Birds will be captured on booming grounds in Nebraska and/or South Dakota and translocated during the breeding season within the existing booming ground complex surrounding the original 1992 release. It is believed the presence of existing booming grounds and associated birds reduces the tendency for translocated prairie chickens to move away from the release site (Toepfer 1976).

Effects of removal

A total of 167 prairie chickens (approximately 40 birds per year) were translocated to North Dakota (83 cocks, 52 hens and 5 unknowns) and to Illinois (6 cocks and 21 hens) in the early 1990's. In 1993, the cock population in western Minnesota from which birds were removed in 1992 declined approximately 50%. Cock counts for individual booming ground counts indicated that the removal of birds from western Minnesota in 1992 did not contribute to this decline. A comparison of booming ground counts between grounds where birds were removed in 1992 (Twin Valley area) with those where none were taken showed the latter declined 59% (157 to 65, N=5) while the former declined 43% (150 to 85, N=5). The Twin Valley area was selected for comparison because it had the most complete booming ground counts for both years. Toepfer (1988) also found the removal of prairie chickens in 1977 from central Wisconsin had no adverse effects on the cock population the following April. Heavy rains, cool weather and the influences of the 10-year cycle probably better explained the drop in prairie chicken numbers from 1992 to 1993 in western Minnesota (Fig. 3).

Research Summary

Except for periodic census efforts, no intensive research was conducted on Minnesota prairie chickens until 1975. Three graduate students from the University of North Dakota conducted studies in the northwest range southeast of Crookston in Polk County. Jorgenson (1977) compared land use in the Minnesota study area with an area near Manvel, North Dakota which had recently (1973) supported prairie chickens, and monitored movements of radio-tagged males during spring and summer in Minnesota. Svedarsky (1979) conducted a 3-year study of female reproductive ecology which evaluated spring and summer movements, nesting, and brood rearing. Sparling (1979) did a comparative study of the reproductive behavior of prairie chickens and sharp-tailed grouse to better understand factors contributing to, and the consequences of, hybridization. Their ranges overlap near Crookston and Sparling studied mixed display grounds occupied by both species. In 1992, the previously discussed North Dakota reintroduction study of Toepfer and his students was initiated and included studies on the winter and reproductive ecology in both states and the prairie chicken use of CRP lands.

CENSUS PROCEDURES

Although some booming ground counts were conducted in the 1950's and 1960's, the most thorough effort to census the northwest range was commenced in 1974 by the MPCS and is on-going. Cooperators included MN DNR, USFWS, and TNC personnel, university researchers, students, and bird-watchers who attempted to count males on each ground twice during the mid-April peak display period. Some experimental winter aerial counts were conducted in Wilkin and Clay counties (Paterson 1973), and the census area of the Crookston and Buffalo River State Park, Audubon Christmas Bird Counts includes some prairie chicken habitat.

HUNTING

Prairie chicken hunting was a long-standing tradition in the prairie country of Minnesota until the last hunting season in 1942. Swanson (1940) cited an 1883 newspaper article from Fergus Falls (west central Minnesota) which noted that in August there were "ten thousand dogs and as many hunters ready for the prairie chicken season." As recently as 1924, prairie chickens were so numerous in Minnesota that no legislation to control their shooting was considered necessary (MN Cons. Dept. 1924). According to older residents of the prairie chicken country, prairie chickens were the main source of "red" meat during the winter and early spring of the Depression years.

The prairie chicken is presently listed as a species of "special concern" in Minnesota (Coffin and Pfannmuller 1988) which means it is not currently threatened with extinction but is a "watch closely" species, dependent on a habitat which could change rapidly. Many biologists however, feel that the population could support a conservative hunting season. Two

possible frameworks are: 1) issue a specified number of permits for a 9-day season with a 1 or 2 bird limit and a success rate regulated by the season dates, or 2) allow a 1-bird limit for an unrestricted number of hunters for 1 weekend in November (R.E. Farmes, MN DNR, *pers. commun.*). Required registration of kills and reports of crippling would be desirable.

A hunting season could create more interest in the bird and its habitat, and affirm that hunting is not a threat to populations in good habitat. Possible negative aspects are: the overharvest of isolated habitats, adverse public reaction from people accustomed to the bird not being hunted, trespass violations, and costs of administering the hunting season.

PUBLIC NEEDS

The prairie chicken has considerable educational and recreational potential and has been an effective selling point in prairie acquisition programs in Minnesota because of its historical significance and the special dimension it adds to the prairie fauna. It perhaps serves as a useful indicator species of the health of the prairie agriculture ecosystem.

Observing booming grounds from blinds and vehicles draws many people to the prairie in spring and could be promoted even more, provided sufficient personnel were available to regulate viewing and minimize disturbance. Presently, blinds for the public are made available on a word-of-mouth basis by personnel from MN DNR, TNC, and the University of Minnesota; photographers occasionally have their own blinds. Buffalo River State Park east of Moorhead is well-suited to develop the interpretive potential of prairie chickens with a TNC field station located nearby and the proximity to population centers of Moorhead, Minnesota and Fargo, North Dakota. Interpretive brochures on prairie chickens are available, and cooperative programming could be developed between MN DNR, TNC, and nearby educational institutions, especially the Science Center of Moorhead State University.

An important focal point for prairie chickens is Rothsay, dedicated in 1976 as the "Prairie Chicken Capital of Minnesota." It has long been known as a prairie chicken viewing area by Minnesota bird watchers and is now marked with a 5 m high prairie chicken statue along Interstate 94. An interpretive kiosk could be developed at this site.

The Minnesota Prairie Chicken Society was organized in 1974 to promote the prairie chicken through educational programs and support management and research projects. An annual meeting and program is held in different locations in the state for the public to learn about prairie chickens. A slide-tape cassette program and brochure were prepared in 1985 by the Society as an educational aid for schools and conservation organizations. More recently, the MPCS has been actively involved in fund-raising to support field research.

MANAGEMENT NEEDS

The Minnesota prairie chicken range lies along the edge of the continental forest-prairie transition where grassland is essentially a subclimax community, maintained in the past by a combination of fire (in particular) and grazing. Aspen (*Populus tremuloides*) and willow (*Salix* spp.) are the primary woody invaders and can rapidly lower the value of a grassland as prairie chicken habitat. The vigorous grassland acquisition program in recent years (Table 2) has now exceeded the management capability of conservation agencies. Presently, agencies annually burn a small portion of their holdings within the primary chicken ranges: MN DNR (8%), USFWS (10%) and TNC (26%). Ideally, about 25% of grassland tracts should be managed annually by burning, mowing or grazing. Spring and fall burning are the most feasible management practices, with opportunities for haying and grazing by private cooperators somewhat limited due to reduced numbers of livestock operations. Pasture and hayland adjacent to acquired preserved grassland is increasingly being converted to grain crops which receive limited use by prairie chickens, especially broods. Consequently, acquired grasslands have to provide more than nesting and roosting cover. Svedarsky (1979) found nesting occurred in undisturbed cover but broods consistently used recently-disturbed cover. He found brood mortality to be quite high and concluded that brood-rearing success was as important as nesting success in determining recruitment. Most acquired grassland tracts within the Minnesota prairie chicken range are large ($\bar{x}$=150 ha) and we suggest that the Hamerstrom et al. (1957) concept of "ecological patterning" be applied to the units themselves to facilitate birds meeting all of their habitat needs within short radius, especially during the summer when movements are reduced.

More recently, Toepfer (unpublished data), in a continuing long-term prairie chicken ecology study initiated in 1992, found 289 prairie chicken nests in western Minnesota; 66.1% in CRP grasslands and 33.9% in grasslands dominated by native species. Nesting success, however, was higher in native than CRP grasslands. The reason for this difference is not known, but CRP grasslands lack species diversity and often consist of only 1 or 2 species; either switchgrass (*Panicum virgatum*), brome (*Bromus inermis*), or brome/alfalfa (*Medicago sativa*). Large CRP fields of dense switchgrass were used only occasionally by hens for nesting in contrast to fields dominated by brome or brome/alfalfa. Native grasslands support a greater diversity of species and may include patches of non-native species.

The pattern of lower nesting success but more nests in CRP grasslands occurred every year since the study started in 1992. This suggests that the quality of grassland habitat, especially the diversity of species, plays an important role in nest success. It would appear that prairie chicken hens do not necessarily "select" the best available habitat. CRP grasslands, because of lower nesting success occurring there, could be a population sink for nesting prairie chickens. Even though there is much more CRP grassland habitat, native prairie areas produce a greater portion of young each year. Management practices should be

developed and then implemented to improve the quality of nesting cover on private as well as public lands (e.g. mowing, rotational grazing, burning, and encouraging landowners to plant native species in idle grasslands).

Increasingly, preserved grasslands are becoming "habitat islands" within intensive agriculture. This has likely increased predation, particularly during the nesting and early brood season. Svedarsky (1988) found December red fox (*Vulpes vulpes*) fur prices (a trapping pressure indicator) highly correlated ($r=0.82$, $P<0.01$) with booming ground counts 2 springs later over an 11-year period (1974-1984). This assumes that heavy trapping pressure during fall and winter results in lower mammalian predator populations and more successful nesting and brood rearing the following summer, which would be reflected in higher booming ground counts the subsequent spring. Recent studies on waterfowl production areas in western Minnesota indicate low upland duck nesting success (8-10%) due to predation (Chuck Vukonich, USFWS, *pers. commun.*). Although predator control programs are difficult and costly, certain habitat modifications can be implemented to reduce predation. These include cover management to provide good chicken concealment and impede predator travel, removal of denning sites such as rock piles, old buildings and bulldozed piles, and cutting large trees which serve as raptor hunting perches. Eastern cottonwoods (*Populus deltoides*) are attractive to raptors and are common along ditch banks often used as loafing sites by chickens. Because it is difficult to kill trees over 12.5 cm d.b.h. by fire, we recommend girdling in April or May or clearcutting in late June when carbohydrate reserves are low to reduce resprouting.

Prairie chicken identification signs have been developed by the Minnesota Prairie Chicken Society to warn hunters that chickens are protected. These are posted around public hunting areas where chickens are present and this practice should continue.

Supplemental winter food through food plots (sunflowers, corn) or baled grain (oats, wheat, corn) may be important to prairie chickens in areas where fall plowing reduces available waste grain. This need may be alleviated somewhat by minimum tillage practices which are gaining acceptance on private land. Also, winter food plots could serve as attractive brood areas if left standing for an additional year and develop a growth of weedy forbs which promotes insects.

RESEARCH NEEDS

As land use continues to intensify around acquired grasslands, managers need to know what is the minimum "island" size needed to maintain chickens assuming that all needs are to be met on the unit. Also, what is the optimum proportion and distribution of habitat types and land uses on a unit to meet the varied life history requirements of prairie chickens?

Woody plant invasion is a critical problem on several prairie tracts. Burning and summer cutting are currently used but alternative brush control methods, including herbicides, need study; these must be cost-effective and environmentally acceptable.

The impact of climate and predation on nesting success and brood survival needs to be better understood as well as ways these effects could be modified by habitat management. In Wisconsin, a scattering of smaller sanctuaries throughout private land was generally felt to be more desirable and feasible than fewer, larger grassland units (Hamerstrom et al. 1957), but Minnesota has relatively large tracts. Fox predation could be reduced on these areas however, if they were large enough to hold coyotes (*Canis latrans*) (Larry Hanson, USFWS, *pers. commun.*). Sargeant et al. (1987) in North Dakota demonstrated that resident red foxes were excluded from the large central portions of coyote family territories which were centered in relatively large roadless areas where cropland was least abundant. More recently, Sovada et al. (1995) found nesting success nearly double (32%) in coyote-dominated landscapes compared to fox-dominated areas (17%). Also, from an overall ecosystem integrity standpoint, larger prairie tracts are superior to small sites (Brian Winter, TNC, *pers. commun.*).

The winter ecology of prairie chickens is poorly understood at the northern edge of the species' range, and unknowns include movement in response to winter food and cover, consequences of these movements, characteristics of night roosting cover, and effects of minimum tillage practices on winter food and brooding areas.

Most of the research in Minnesota has been conducted in the northwest prairie chicken range. We know very little of habitat use and limiting factors in the north central range which was primarily forest in presettlement times and is now a mosaic of forest, brush, cropland, and grasslands.

There is recurring interest in reintroducing prairie chickens elsewhere in Minnesota; however, reintroduction sites require large acreages of open grassland. While this is a worthy undertaking, we place a higher priority on research and management efforts directed towards making existing prairie chicken populations more secure and expanding their distribution before moving birds into other areas.

RECOMMENDATIONS

Habitat is the major factor limiting the greater prairie chicken in Minnesota, with nesting and brood habitat being the most critical. Additional habitat areas must be acquired when available within the prairie chicken range, but the importance of managing existing public grasslands cannot be overemphasized (Maertens 1973, Kirsch 1974).

In 1990, a long-range plan was developed by the Minnesota Department of Natural Resources and included the following section on "Habitat Needs" which serves as a guide to field managers:

> "An ideal prairie chicken management unit should be one-third to one-half in native (preferred) or tame grasslands. Sedge meadows and lowland brush should comprise

about 25%. The remainder can be made up of a combination of cropland, pasture and hayland, with no more than 10% of the unit containing tree groves that exceed 20 ft (6.1 m) in height.

Although unburned grasslands provide nesting and brooding habitats, periodic burning is a practical management tool needed to maintain the vigor of the prairie community. Alfalfa fields cut for hay, lightly-grazed pasture, and first-year legumes following small grains also provide quality brood cover. If left undisturbed, grass-legume seeded areas can also provide desirable nesting habitat. Brood habitat should be adjacent to nesting habitat whenever possible.

Preferred roosting areas are somewhat wet and consist of lowland brush and sedge meadows with less than 10% in willow or other shrubs. These areas are also used to some extent for nesting, and brood rearing during years immediately following burning. Prescribed burning of lowland brush and sedge meadows is necessary to maintain the shrubs in early stages of development.

Natural foods for the prairie chicken consist of wild rose hips and buds of birch, aspen, willow, dogwood, hazel, cottonwood and oak. If surrounding crop fields are not fall plowed, waste grains usually provide an additional source of winter food. Where fall plowing is extensive, strategically located food plots may be beneficial. No-till, ridge-till or other types of farming that reduce fall plowing should be encouraged whenever possible." (MN DNR 1990).

The maintenance of high quality habitat is not as dramatic and newsworthy as when a new area is acquired but they are equally important. Maintaining a tradition of chicken use on an existing area is of higher priority than reestablishing birds on a new area. Prescribed burning is being carried out on an approximate 6-year rotation in the northwest range, but this may stimulate rather than control those woody species adapted to periodic fire (Svedarsky et al. 1986). An aggressive program of prescribed burning, brush control through summer clear-cutting, girdling, and possibly herbicides is needed to maintain high quality grassland habitat for prairie chickens and their associates. Predation should be reduced by: removing raptor ambush trees and mammalian den sites whenever possible, maintaining good nesting cover, and promoting mammalian predator trapping. General information on prairie chickens and their management should be provided to private landowners throughout the prairie chicken range. Incentive programs, such as state wetland and prairie tax credits, Prairie Bank, Reinvest-in-Minnesota, and the Conservation Reserve Program should be promoted to maintain grassland cover on private land.

Management-oriented research should be carried out to better understand brood mortality factors, winter movements, the ecology of predation effects on "habitat islands," and brush control strategies which are cost effective and consistent with long-term management of diverse prairie tracts.

The interpretive potential of prairie chickens is presently underutilized. Increased public support for public and private programs could be gained by additional tours of booming grounds and prairies using prairie chickens as the focal point.

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