The Greater Prairie Chicken
A National Look

W. Daniel Svedarsky, Ross H. Hier
and Nova J. Silvy, editors

University of Minnesota

Miscellaneous Publication 99-1999
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Foreword

It was indeed a pleasure to bring greetings to the 25th annual meeting of the Minnesota Prairie Chicken Society and to welcome readers to the compilation of papers detailing the national status of this unique prairie bird. Once before, in April of 1976, I addressed this meeting and good friends at Rothsay when that community celebrated its Bicentennial and was dedicated as the "Prairie Chicken Capital of Minnesota." Those sorts of events where farmers, biologists, local citizens, community leaders, educators, and politicians get together to have a little fun and commemorate a symbol of good land stewardship is rural America at its finest!

I have fond memories of this bird – and its cousin, the sharp-tailed grouse – having grown up in rural Minnesota near Roseau. I will always remember hunting sharptails with my dad in the 1950s on or near Soil Bank land southwest of Roseau. The birds were abundant, although we weren't sure why. When high grain prices came in the early 1970s, the Soil Bank land was plowed and the sharptails all but disappeared – then I knew why. These prairie grouse are a product of the land and their presence is a sign that the land is healthy. Prairie chickens, in particular, and perhaps people as well, do best when there is a mixture of cultivated agriculture and grassland on the landscape.

As these papers document, current prairie chicken populations are a mere sprinkling of their former range due to a wide array of limiting factors. But one of the major factors was too intensive land use which sent too much of our precious topsoil to the sea. Along with this irreplaceable soil goes nutrients and agricultural chemicals which can foul our waters. We have returned much of the erodible lands to grass cover through the Conservation Reserve Program and we have continued to diversify planting mixtures to improve wildlife habitat values for prairie chickens and other imperiled grassland species but there is more to do. We are witnessing a major exodus of farmers leaving the land and a noble way of life behind. We must reverse these forces by diversifying rural America in a sustainable fashion that celebrates wild areas alongside agriculture and healthy families connected to the land.

I salute the efforts of the many people working, in their own way, to study and support wildlife like the greater prairie chicken. You point the way on how good biology can be integrated with wise land use so we can move forward with pride into the new century enjoying the benefits of modern society and the pleasures of wild things.

Robert Bergland
University of Minnesota Regent
and former U.S. Secretary of Agriculture


Save CRP!
- Save soil
- Clean water
- Habitat
WE LOVE OUR CRP GRASS
VOTE "YES" FOR GRASS
WE CHICKENS VOTE "YES" FOR CRP
KEEP IT IN GRASS!
WE ALL NEED CRP GRASSLAND
CONSERVATION RESERVE PROGRAM - "YES" Saves Soil & Water

Preface

In the winter of 1972-73, a couple of wildlife managers and a college instructor got together over coffee and donuts and brainstormed on how the prairie chicken was doing in Minnesota and if more should be done – by people. A lot had already been done – by agency field people who had acquired the "good grass" in various programs that provided the all-important habitat base. A bunch of meetings later, and a prairie chicken organization was launched – inspired by the Wisconsin model of the Society of Tympanuchus Cupido Pinnatus and Fred and Fran Hamerstrom.

Twenty-five years later, the Board of Directors of the Society met to plan the Silver Anniversary meeting and decided to really broaden the scope to include not only a look at our own history, but the national scene as well. A number of status papers for states had previously been prepared for a book that was to include greater and lesser chickens and sharptailed grouse and would be published by the Prairie Grouse Technical Council. Nova Silvy, of Texas A & M University, organized that effort which resulted in early versions of most greater prairie chicken papers. Authors of those papers were contacted and invited to update and submit them for this publication. Several were able to attend the meeting at Crookston and present their papers on 25 April 1998.

It was a time for celebration as well as thoughtful reflection. In the 25-year span, prairie chickens had held their own for the most part in Minnesota but such was not the case in some states. We were fortunate in Minnesota to have had a healthy land base to focus management on, in addition to expanded acquisition efforts. It is instructive to see what works and what doesn't in the conservation of a species distributed over a wide range of habitats and climates. A species recovery effort is apparently working in Illinois where greater prairie chicken numbers and genetic fitness had declined to perilous lows but were "rescued" by the introduction of new genes in transplanted birds. This project was made possible by advances in genetic analysis techniques as well as the meticulous, long-term field work of Ron Westemeier. A paper by Westemeier and co-workers was recently published in the prestigious journal, *Science*, in recognition of the landmark nature of their findings and potential applications. We are grateful to Ron for bringing his many years of working with prairie chickens to develop the symposium summary paper herein, along with Sharron Gough of Missouri.

A case history on the Attwater's prairie chicken in Texas is included to profile an "against all odds" scenario described by Nova Silvy. It is hard to imagine a current conservation setting with more challenges than Attwater's chickens, and yet their status 25 years ago, although endangered, certainly did not seem dismal. Let us learn from this example, fine tune and adjust our research and management efforts in species conservation, and above all, never get complacent as we help a species experience success.

Ross Hier provides a glimpse of the storied past of prairie chicken hunting traditions in his paper. Prairie chickens have many values – as profiled by Grady Mann – and they have a solid place in the early settlement, sociocultural history of the prairies. It was sustenance, certainly, but chicken hunting was much more. It defined community events, get-togethers of family and friends, and commerce in some cases. We will never again see

those days of great chicken abundance but it is stirring to see and hear a misty-eyed 80-year-old say he would "like to just see one, once again."

From the outset, an underlying goal of the Minnesota Prairie Chicken Society was to have some fun while saving a species. Again, our model was the Wisconsin Society of Tympanuchus Cupido Pinnatus, where the annual meeting is a cocktail party! And we heed an admonition by the late Fred Hamerstrom that, "*Good works do not need to be done in a sepulchral atmosphere.*" Indeed, you will even find Ross Hier cartoons sprinkled amidst the serious scientific papers within this publication.

Fred and Fran Hamerstrom were inspirational reference points for many segments of conservation — not only in their counsel but in their work and how they lived their lives. We humbly dedicate this publication to their memory for they clearly pointed the way for conservation of prairie chickens in North America.

More on reference points. When folks know you work with prairie chickens, the welfare of the bird is often the lead-in for conversation; perhaps more so than the old standby of the weather. "Well, how are the chickens doing?" is commonly the second statement after "Hello." It's as if it is a measure of how the world is doing in general; the end point of some sort of biotic equation where *grass condition + predation + weather at hatching + disease + winter food, etc. = x prairie chickens.* Certainly, there is an anxious anticipation of the spring censusing season when chicken counters fan out in the Minnesota range to see, "how the world is doing," according to the chickens.

A number of people and organizations helped to make this publication a reality. The many authors who searched for, dusted off, and revised old manuscripts or in some cases wrote new papers. The organizations providing funding include: the Minnesota Prairie Chicken Society; the Northwest Experiment Station and the Minnesota Agricultural Experiment Station of the University of Minnesota located at Crookston and St. Paul, respectively; Society of Tympanuchus Cupido Pinnatus, Ltd. through president William Schallert; the Department of Fisheries and Wildlife, Texas A&M University, College Station; and the Pembina Trail Resource Conservation and Development Association. Karen Smith, refuge manager at the Lostwood National Wildlife Refuge in Kenmare, North Dakota, provided the artwork used on the cover as well as on Society note cards, and for a belt buckle and brochure. Cartoons and other sketches are by Ross Hier, assistant wildlife manager with the Minnesota Department of Natural Resources based at Crookston. And, a big thanks goes to Larry A. Etkin, senior editor with the Minnesota Agricultural Experiment Station, who guided the publication process and understood delays by the editors.

As this publication goes to press, the Minnesota Prairie Chicken Society has just been informed that it will receive the 1999 Group Achievement Award of The Wildlife Society. This prestigious national award commemorates an organization's "outstanding wildlife achievements while advancing the objectives of The Wildlife Society." This is humbling and capstone recognition to a bunch of people who set out to have some fun while helping a prairie bird that does an outrageous courtship dance in the spring.

Enjoy the proceedings.

Dan Svedarsky, proceedings co-editor
Brian Winter, president, Minnesota Prairie Chicken Society

April 1999

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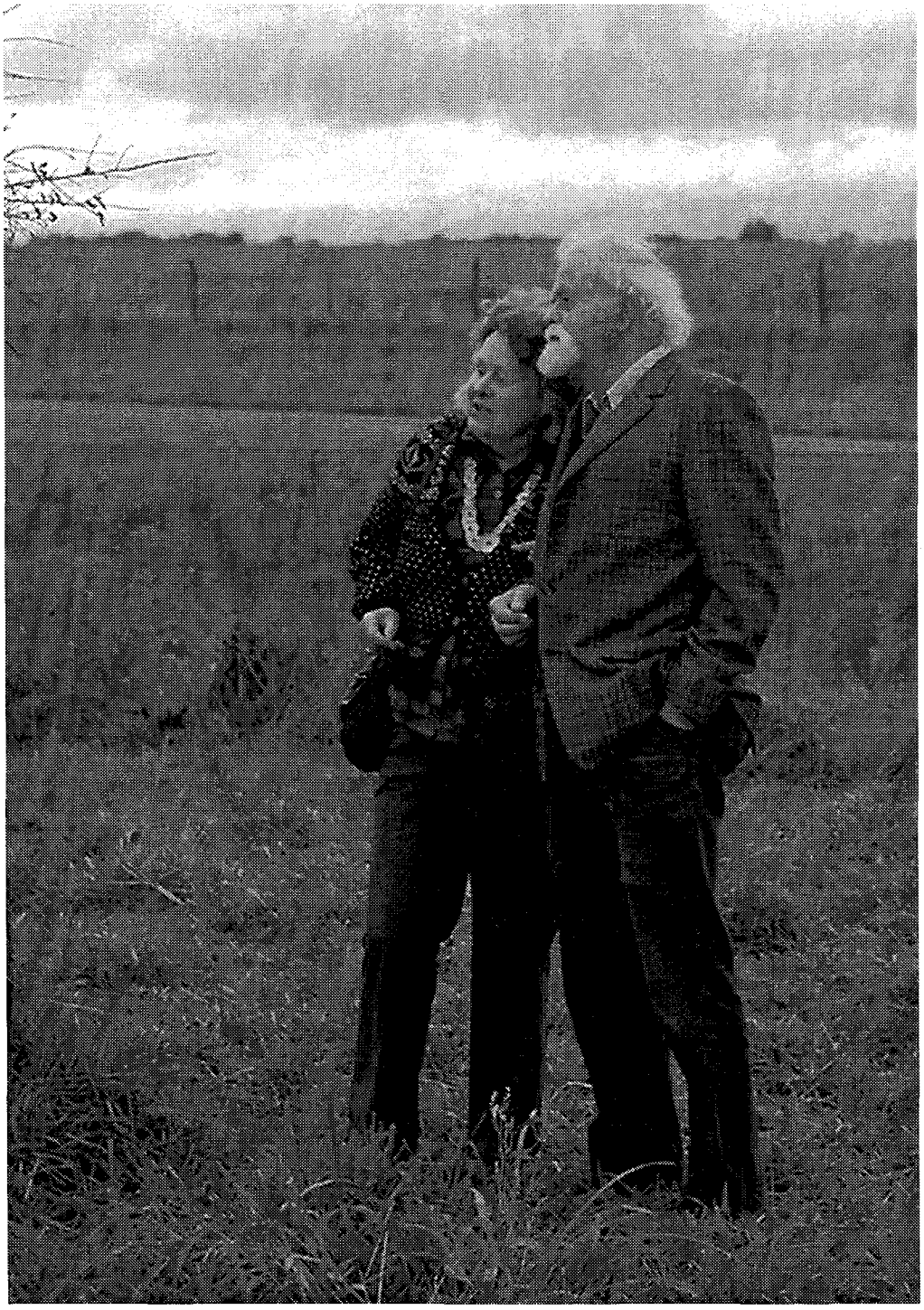

Frederick and Frances Hamerstrom.

A Tribute to The Hamerstroms[1]

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Dale E. Gawlik, Everglades Research Systems, 3301 Gun Club Road, West Palm Beach, FL

The number of people who truly have a singular effect on one's life and career are few. We are privileged to have been so influenced by Frederick and Frances Hamerstrom and this is our tribute to these remarkable people.

Dr. Frederick N. Hamerstrom, Professor of Wildlife, and a "quiet scientist" of international repute, died near Idleyld Park, Oregon, on 28 March 1990, in a place of his choosing, a cabin on the Umpquah River. His last experience in life, as he considered it, was shared with Dr. Frances Hamerstrom, his wife and life-long research colleague of similar fame, in a manner that was typical of their 59 years of marriage. Dr. Hamerstrom was an idealistic model for wildlife professionals throughout this life; his moment of death was no exception.

Fred, known as "Hammy" to his close friends, began his wildlife career at the Game Conservation Institute, Clinton, New Jersey, in 1931 learning artificial propagation of game birds after having earned an A.B. degree at Harvard College and marrying Frances Carnes Flint that same year. Thus was forged one of the most remarkable wildlife research teams known to the field of wildlife ecology.

Fred was a Research Fellow under Dr. Paul L. Errington at Iowa State College from 1932 to 1935 where he and Fran (pronounced, "Fron") studied pheasant nesting, winter ecology of bobwhite quail, and raptor food habits. Their paper, *"The great horned owl and its prey in the north-central United States,"* co-authored with P.L. Errington, won The Wildlife Society's first Terrestrial Publication Award in 1940. The first cooperative Wildlife Research Unit was established at Iowa State in 1932; Dr. Errington was its first leader and Frederick Hamerstrom, its second graduate student, earned a M.S. degree and Frances a B.S. degree there in 1935.

The Hamerstroms made their first research contact with prairie chickens in 1935 when Fred became Project Game Manager for the U.S. Resettlement Administration's Central Wisconsin Game Project near Necedah, Wisconsin. Although the prairie chicken was to become their major focal point in succeeding years, they also dealt with sharp-tailed grouse, ruffed grouse, sandhill cranes, furbearers, deer, food habits of great horned owls, winter feeding, food and cover plantings, and development of water areas.

[1] *Portions of this combined tribute appeared in the Wildlife Society Bulletin (1991. 19[1]:119-122 and 19[4]: 378-379) and the Proceedings of the 18th Prairie Grouse Technical Conference Proceedings for Frederick Hamerstrom. A memoriam for Frances Hamerstrom was in the Journal of Raptor Research (1998.32: ii-iv).*

The Hamerstroms were Research Fellows at the University of Wisconsin under Aldo Leopold from 1937 to 1941. Fred earned a Ph.D. degree in 1941, and Fran an M.S. degree in 1940. Frederick is 1 of only 3 to earn a Ph.D., and Fran is the only woman ever to have earned a graduate degree under Leopold. They continued their research on prairie chickens and sharp-tailed grouse in Wisconsin during the spring seasons of 1941 through 1943, and then again in 1947 and 1948 while Fred was Curator of the Edwin S. George Reserve in Michigan. They also studied prairie chickens and sharptails in Michigan and predators and deer on the Reserve during this time. Fred served in the U.S. Air Force from 1944 through 1946 as an Aviation Physiologist and Fran was a medical technician at the U.S. Army Beaumont General Hospital in El Paso, Texas.

Hamerstrom's research on prairie chickens provided tools for other ornithological studies. They were among the first to color-mark wild birds by using the falconer's technique of imping colored feathers into the pinnae and tails of prairie chicken cocks, discovering that cocks were territorial on booming grounds. Fran irreverently wrote, to Aldo Leopold's delight, this poem about the episode:

The prairie hen will wonder soon,
but not because her love goes boom.
Consider with what joy, she'll hail
the colored feathers in his tail.

Fred was instrumental in creating a prairie grouse trapping cooperative with Jack Manweiler. Curiously, trapping prairie chickens for banding was extraordinarily difficult in the 1930s and 1940s. His trapping and banding program saved money by showing that prairie chicken food patches could be 5 miles apart rather than 1 per square mile.

Fred was employed by the Wisconsin Department of Natural Resources (WDNR) from 1949 through 1972 as Project Leader of the Prairie Grouse Management Research Unit headquartered in Plainfield; Fran was Assistant Leader. Early in this period, the Hamerstroms and Os Mattson, WDNR land manager for the project, formulated a management plan to "save the prairie chicken" in Wisconsin. This was published as *"A guide to prairie chicken management,"* a WDNR Technical Bulletin that received The Wildlife Society's Wildlife Publication Award in 1958. The scatter-pattern plan of land management introduced a new concept which has been applied for other species, including some in the rainforests. The plan was designed for the Buena Vista Marsh area where the Hamerstroms concluded that the chicken had the best chance of being maintained for a variety of reasons. Land values were low, the chicken population was still in good shape because of the existing habitat, and there was little competition for uses of the land.

After the plan was designed and presented, 2 foundations, The Society of Tympanuchus Cupido Pinnatus and The Prairie Chicken Foundation, competed – in a friendly manner – to buy lands needed to save the chickens. About 12,000 acres were bought in roughly the pattern recommended in *A guide to prairie chicken management.* The Hamerstroms and Mattson were also actively involved in implementing the first management efforts to maintain grasslands in the face of ever-present natural succession of shrubs and trees that were persistently reclaiming the area. Land acquisition and subsequent management stopped the decline of the prairie chicken population on the Buena Vista Marsh and fostered its resurgence to the 1950 level by 1981.

The Hamerstroms continued their chicken population research on the Buena Vista and published their population and management data in 1973 in another WDNR Technical Bulletin, *"The prairie chicken in Wisconsin: highlights of a 22-year study of counts, behavior, movements, turnover, and habitat."* They retired from the WDNR in 1972 but maintained an active interest in the population dynamics and management of the prairie chicken as Faculty and Research Associates (1972-1982) and Adjunct Professors (1982 until their respective deaths) at the University of Wisconsin–Stevens Point.

Virtually all of the main range of the greater prairie chicken and some of the range of the

lesser and Attwater's prairie chicken in the United States, and most of the range of the sharptail races *campestris* and *jamesi*, plus some of the range of 3 of the other 4 races in the United States and Canada, were examined by the Hamerstroms. They made 5 trips to Europe (Germany, Austria, Finland, Lappland, Norway, Sweden, and Denmark) to study grouse in particular, and to study red and roe deer, hunting traditions and ethics, and general conservation, and to speak at several universities and meeting of ornithological societies. They were members of 7 International Ornithological Congresses and were invited speakers at 6 of them. They spent 1 month in Australia's outback and visited India, Iran, Siberia, and Sri Lanka for conservation-oriented purposes. They initiated a continuing study of Harris' hawks in Texas and of an osprey population in Sonora, Mexico.

By 1990, the Hamerstroms had published 168 papers and articles, 10 books, and about 50 reviews between them. Fred was a highly skilled technical writer and editor. In addition to editing 10 books that were published by Fran, the last one only 2 days before his death, he refereed technical papers for several journals and was the Principal Referee for the journal, Raptor Research. He served on several graduate committees at UW–Stevens Point and thus was a mentor for wildlife students in areas of research planning, design, execution, analysis, and writing. He also shared his wealth of knowledge and experience with numerous other wildlife apprentices in his home which was a classroom, library, laboratory, dormitory, research headquarters, and social center that often echoed with good music and laughter. Dr. Hamerstrom's philosophy of life included his admonition that..." *Good works do not need to be done in a sepulchral atmosphere."*

He was a charter member of The Prairie Grouse Technical Council and, in 1992, that group initiated, "The Hamerstrom Award" to recognize an individual or organization who made exemplary contributions to prairie grouse conservation. Fred was an active member of the following conservation-oriented societies and committees: American Institute of Biological Sciences; British Ecological Society; Prairie Grouse Cooperative (Secretary); Saskatchewan Natural History Society; Tall Timbers Association; American Ornithologists' Union (Chair, Emergency Committee for Relief of European Ornithologists); Chihuahuan Desert Research Institute (Board of Scientists); Citizens' Natural Resources Association (Councilor); Deutsche Ornithologen-Gesselschaft; Ecological Society of America; The Nature Conservancy ; National Wildlife Federation; Raptor Research Foundation (Principal Referee); The Wildlife Society (Editorial Board, Leopold Award Committee); Wisconsin Academy of Science, Arts and Letters (Co-Vice President for Science); Wilson Ornithological Society (Chair, Conservation Committee, Associate Editor); Wisconsin Society for Ornithology (President, twice; Co-Chair Research Committee).

Professor Hamerstrom's distinguished public service and high quality research did not go unrecognized, though he was a very modest man. Fran called him "a quiet scientist."

Fred Hamerstrom was recognized with the following Honors and Awards: The American Ornithologists Union–Fellow; Dane County Conservation League–Distinguished Cooperative Wildlife Research Unit–Certificate of Recognition; Phi Kappa Phi; Sigma Xi; and jointly with Fran, Citizens Natural Resources Association–Silver Acorn Award; College of Natural Resources, University of Wisconsin-Stevens Point–Environmentalist of the Year, 1978; National Wildlife Federation–Wildlife Conservation Award; United Peregrine Society–Conservation Award; The Wildlife Society–Wildlife Publication Award, 1940 (with P.L. Errington for *"The great horned owl and its prey in north-central United States"*) and again in 1958 (with O.E. Mattson for *"A guide to prairie chicken management"*); Wisconsin Chapter, The Wildlife Society–Wisconsin Award for Wildlife Research, 1980; Wilson Ornithological Society–Edwards Prize (with C.J. Burke); Wisconsin Department of Natural Resources–Bureau of Research Award; Wisconsin Outdoors Communicators Association–Honorary Life Members; Wisconsin Society for Ornithology–Silver Passenger Pigeon Award for Service to WSO, and Honorary Life Membership Award for distinguished ornithology.

Dr. Hamerstrom left an indelible wildlife legacy that can be realized each spring when prairie grouse greet the sunrise with their booming, dancing, strutting, and when they take wing from cover during the fall hunting season; whenever the eye is privileged to the sight of a soaring buteo, hunting harrier, diving osprey, stooping falcon, or darting accipiter; or when one gets that unique tingle in the nape of the neck while treading grasslands with "buena vistas." His scholarship, ethical research standards, unselfish dedication to the conservation of natural resources, all flavored with the modest character of a gentleman, provided a model for wildlife scientists that inspires emulation. He was a Professor of Wildlife and Conservationist of the highest order. *"I am grateful for having had the opportunity to be one of his students, a relationship that never ceased--I sensed that I was in the presence of greatness"* (Ray Anderson).

Frances Hamerstrom died 29 August 1998 at age 90 in Port Edwards, Wisconsin. She published over 150 scientific papers (many with Fred), dozens of popular articles, and 12 books. She once remarked that *"if you are the kind of person who wakes up every morning wanting to make the world a better place, it gives a certain zest to everything you do"*. Those who knew Fran will agree; there was a certain zest to everything she did.

Despite the societal stuffiness of her privileged childhood, Fran was drawn to wild animals at an early age. Her fondness for raising young wild animals and nursing sick ones to health reinforced in her mind that she was different from other people in her social setting. It also laid the foundation for a "hands-on" style of wildlife research that emphasized personal contact with the animals of study. To Fran, bringing free-flying raptors into her household to study them just made good sense. It seemed odd to her to think that a scientist could ask meaningful research questions without having first-hand knowledge of an animal's daily needs.

Fran's research style and personality complimented those of her husband and teammate, Frederick, who preceded her in death by 8 years. This exceptional life-long team was appropriately labeled a "super organism" by an anonymous apprentice. Thus, it is virtually impossible to refer to them individually in their wildlife careers. That is not to say that they behaved alike. Fran was often spontaneous and impulsive whereas Fred was methodical and meticulous. Fran was sometimes outspoken and prone to embellishment whereas Fred was the quiet master of understatement. Both were fiercely committed to saving our natural heritage. They accomplished so many things together because their differences strengthened their sum.

Fran was in the vanguard of "equal opportunity" for women in wildlife biology long before it was popular or even considered. The male-oriented profession precluded specific employment in her early professional life and significantly limited it later on. Fran was keenly aware of the male chauvinism associated with the embryonic wildlife profession and would subtly call attention to this fallacy by physically out-manning men in the field. Her relatively recent book, *"Is she coming too?"* is testament to this historic awareness. When Fred gained an educational appointment, or employment, Fran accompanied him and participated as a volunteer, or pursued complimentary avenues. Her efforts were soon recognized and occasionally rewarded with a token salary, but more often the agency got 2 highly qualified people for the price of 1 as they conducted field research on a number of species.

While working under Paul Errington at Iowa, Fran received an award for "the woman most likely to succeed in research" and later was awarded an honorary doctorate degree from Carroll College in Waukesha, Wisconsin in 1961. The lifetime achievements of Fred and Fran are even more remarkable when one considers that they conducted exhaustive field studies on harriers, osprey, kestrels, Harris' hawks, and several other species coincident with their tenure on other official projects. They were stellar role models.

Although Fran's research on grouse was more noteworthy to many, she always held a special fascination with raptors. Her first major scientific paper (co-authored with Errington

and Fred) was on the food habits of great horned owls. Ironically, the paper was a disappointment to her. As a woman in a male-oriented profession, she felt a strong need to prove herself by publishing her first significant paper as the sole author. Errington just assumed she would want her relatively small contribution to become part of his major paper. She went on to publish 70 papers on birds of prey and to receive The Wildlife Society's publication award (as a co-author with Fred and Os Mattson) a second time in 1957 for her work on prairie chicken management.

One of Fran's most exhaustive studies was a long-term project on the breeding ecology of northern harriers in central Wisconsin. From the 1950s to 1980s, she and co-workers banded close to 300 adult and 650 nestling harriers, and conducted over 20,000 small mammal trap nights. She documented that food abundance was the mechanism regulating harrier mating systems and local population densities. She also noted that those relationships changed during the years that the pesticide DDT was used. The 25-year harrier study was published in a book by Fran entitled, *"Harrier, hawk of the marshes: the hawk that is ruled by a mouse."* Keeping with her habit of maintaining several research projects simultaneously, Fran also conducted a long-term nest box study of American kestrels.

Raptors held more than a scientific interest for Fran. She was an accomplished falconer who, at age 12, took her first quarry with a male kestrel. Later she helped pioneer artificial insemination techniques with golden eagles. It was not uncommon for Fran to apply traditional falconry techniques in her raptor research projects. She maintained close ties to falconers throughout her life and was a member of the North American Falconers Association, the British Falconers Association, and the Great Lakes Falconers Association.

Her lifetime interest in raptors also made Fran an early supporter of the Raptor Research Foundation. She received the President's Award from the Foundation and was the Central Director in 1975 and 1976. In 1990, the Foundation created the "Frederick and Frances Hamerstrom Award" given to individuals who made significant contributions to the understanding of raptor ecology or natural history. In 1992, the Journal of Raptor Research dedicated a special issue to the Hamerstroms' contribution to science.

After Fred's death, Fran journeyed to tropical rainforests, a region that apparently always intrigued her but which Frederick had little desire to visit because of the heat and humidity. She initially traveled to the Congo where she "hunted with the pygmies" as she put it. She made at least 5 consecutive trips to the Amazon basin, always traveling alone and training physically for the ordeal beforehand. She was initially interested in the hunting practices of rainforest societies and started to collaborate on a book on that subject with a native. But, like the birds she studied, Fran returned to Wisconsin each spring to continue her research on kestrels.

Few people in the profession of wildlife biology have earned so many awards from such a breadth of organizations. She received the Josselyn Van Tyne Award from the American Ornithologist's Union, the Chapman Award from the American Museum of Natural History, the United Peregrine Society Conservation Award, the Edwards Prize from the Wilson Ornithological Society, and was the first recipient of The Hamerstrom Award from the Prairie Grouse Technical Council. A sample of other organizations that bestowed awards include, the Raptor Research Foundation, The Wildlife Society, National Wildlife Federation, International Crane Foundation, Citizens Natural Resources Association, Deutschen Ornithologen-Gesellschaft, Wisconsin Department of Natural Resources, Wisconsin Society for Ornithology, and Wisconsin Academy of Sciences, Arts and Letters. Fran was a member of over 20 scientific societies including all the major North American and several European ornithological societies, The Wildlife Society, Raptor Research Foundation, Ecological Society of America, and the American Society of Mammalogists. She also was a member of several wildlife conservation societies and writers associations. In the last 20 years of her life, Fran devoted more time to writing popular books and preferred to be defined as a writer rather than an internation-

al wildlife biologist. Her book, "*Strictly for the chickens*" won the August Derleth Award.

One of Fran's least-recognized contributions to the field of science was her service as an educator and role model. The Hamerstroms employed a European model of apprenticeship whereby they allowed qualified individuals to live in their home and become part of their daily lives. The 100 or so apprentices were called "gabboons." The term means slaves that conduct the lowest form of labor. During the banquet at a Raptor Research Foundation annual meeting, Fran looked around the room and pointed out the large number of Foundation officers and meeting attendees who had been through the Hamerstrom household. It was a testament to the influence the Hamerstroms have had on the field of raptor research.

The gabboon system ensured that science was only part of an apprentice's learning experience. Gabboons were treated to introductions with visiting professionals from all over the world. Since before World War II, the Hamerstroms had strong connections to European scientists. Gabboons were schooled in subjects as diverse as proper table manners, correct English, and carpentry. They also enjoyed Fran's fine cuisine, which was the subject of her wild foods cookbook. Anyone who washed dishes and put the antique china back in the cupboards quickly realized that every piece had its place and it was not negotiable.

Certain strict household rules evolved as a defense against legions of houseguests each year. Like Leopold, the Hamerstroms imparted on gabboons a strong appreciation for fine art and disdain for the trappings of technology. The walls of their unpainted pre-civil war construction farmhouse in rural central Wisconsin were adorned with original art work. The house had no indoor plumbing but each person was allowed private bathing time at "the pond" where they had a chance to see a green heron or a brood of wood ducks.

Fran's model for a biologist was one with more field sense than statistical prowess or experimental design skills. This view was also evident in most of her publications, which often lacked statistical rigor but were rich with high-quality data. Her thoughts on statistics were that if a pattern wasn't obvious from a look at the raw data, it either wasn't real or more samples were needed to know for sure. She lamented the fact that contemporary students often knew very little basic biology about the animals they were studying even though they may have had a good grasp on the scientific process.

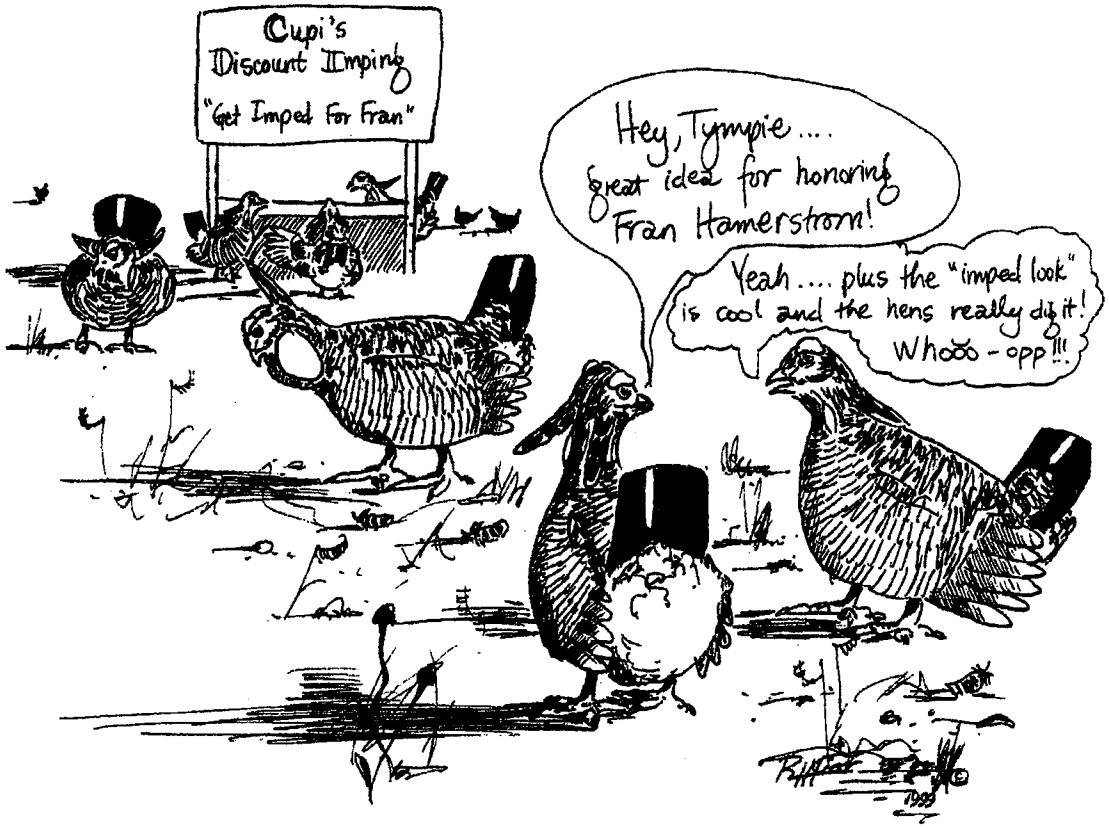
The Hamerstroms set the standard for a dedicated work ethic. They used their home as a research center, they brought gabboons into their daily lives, and they believed that if animals did not recognize weekends and 8-hour days, it didn't make sense for researchers to do so either.

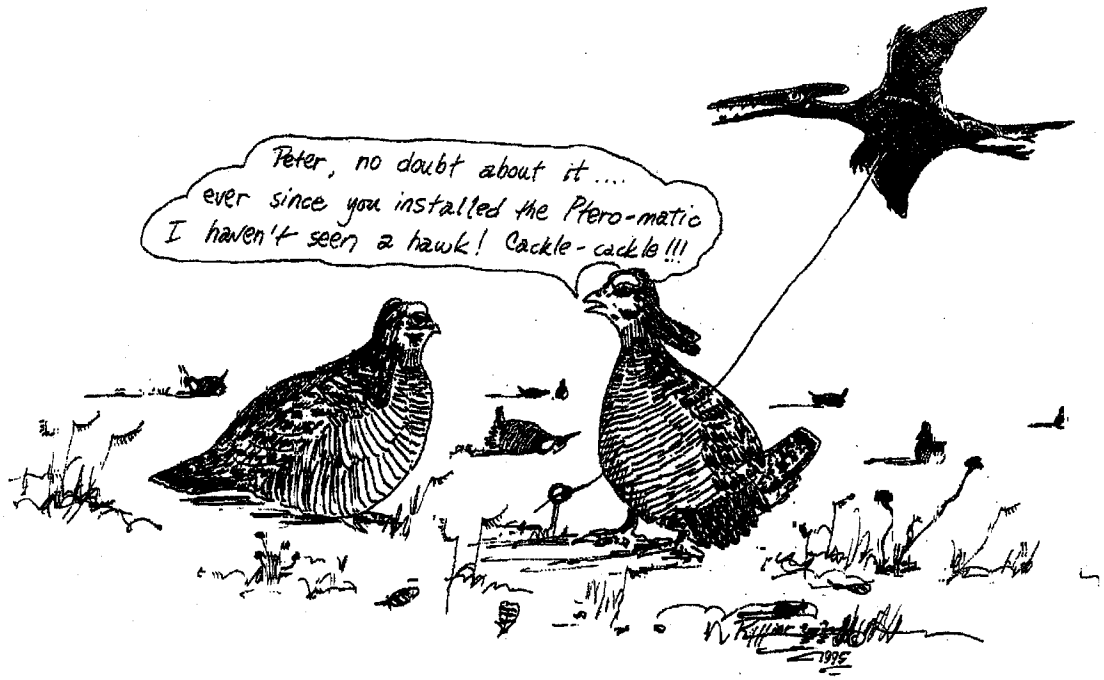
It was obvious that wildlife research was far more of a passion for the Hamerstroms than a job. This philosophy stemmed from Leopold's expectations of his graduate students and was the basis for the "Hamerstrom rule of thirds." The rule is that researchers should spend one-third of their time on the bureaucratic folly required by their employer. Another one-third of their time should be spent on tasks both the employer and the researcher want to do, and one-third of their time should be spent doing exactly what the researcher pleases. Fran was quick to note that this last one-third was beyond a regular 40-hour week, and she maintained it was that portion of their time that made the prairie chicken work a success. Even while in Michigan from 1943 to 1946, she and Frederick took personal time to visit the booming grounds in central Wisconsin each year to monitor their marked birds.

Fran also was a model in her advocacy of keeping wild pets. She believed that if the public was to really appreciate wild animals they must be allowed to experience them first hand, much as she had done as a child. She believed the risk of harm to an individual wild pet was less than the benefit of letting a child feel the wonder and responsibility of caring for that pet. Although Fran rehabilitated many injured wild animals over her lifetime, she realized in mid-life that emphasizing the wel-

fare of an individual animal over that of the population was misguided. In her book, *"Strictly for the chickens,"* Fran tells the story of capturing a hen prairie chicken with a nasty infection. Fred was ready to end the bird's suffering and make a study skin from it. Fran intervened and cleansed the wound, stitched it up, and released the bird. Years later she recaptured the same hen and thus became somewhat of a heroine for saving its life. Of that incident Fran wrote, *"But year after year I watched the range of our prairie chickens disappear under the plow and drainage. And I began to grow up. I came to realize that the saving of one individual for sentimental reasons is nothing compared to preservation of habitat for a species. Frederick knew this all the time."*

Even in death Fran was a role model. She saw countless life and death cycles through harrier and meadow vole population highs and lows. Better than most people she knew that in nature, death was necessary and healthy for the good of the population. As with her husband, Frederick, and former professor, Aldo Leopold, there was no funeral so that death would be mourned; funerals are for the living and the commercial enterprises that materialize out of the death event. Instead she slipped quietly away to become part of that natural cycle she spent her live preserving.




Peter, no doubt about it....
ever since you installed the Ptero-matic
I haven't seen a hawk! Cackle-cackle!!!

An Overview: The Minnesota Prairie Chicken Society

W. Daniel Svedarsky, Northwest Experiment Station, University of Minnesota, Crookston

I had never seen a prairie chicken before I accepted a position at the Crookston campus of the University of Minnesota in the fall of 1969. I had heard of them though. When I was a student at the University of Missouri, Missouri Department of Conservation biologist, Don Christisen gave a stirring talk to the Wildlife Club about prairie and prairie chickens. I can still see in my mind's eye, one of his slides showing a displaying male silhouetted against a red sunrise.

Gerald Maertens was the wildlife manager with the Minnesota Department of Natural Resources based at Crookston and introduced me to displaying prairie chickens and sharp-tailed grouse east of Crookston near Marcoux Corner. It was a memorable early morning as we watched the "orange balloons" inflate and produce the odd booming sound. I'm sure, at the least, I said, " *Wow!*" I immediately began taking my students out to enjoy the spring spectacle. Maertens had worked in the Crookston area for a number of years and had grown to be a passionate supporter of the prairie. He not only celebrated the aesthetics of prairie, through excellent photography and talks, but worked hard and effectively to purchase remnant prairie tracts in the 1960s and early 1970s.

Maertens then transferred north to the Thief Lake Wildlife Management Area and was replaced at Crookston by Terry Wolfe. I was aware of the prairie chicken conservation effort in Missouri and later of the Wisconsin program led by Fred and Fran Hamerstrom and the group which they helped found, The Society of Tympanuchus Cupido Pinnatus. Noteworthy, too, was the work in Illinois coordinated by Ron Westemeier and Glen Sanderson of the Illinois Natural History Survey in conjunction with The Nature Conservancy.

Maertens, Wolfe and I met for a brainstorming session in mid-winter of 1972 to discuss what could be done on the Minnesota scene for prairie chickens. They were still here, but where and how many? Were their numbers secure or were they in need of a specific conservation effort? Maertens had personally witnessed a steady decline in prairie habitat and disappearing booming grounds in his work area, but was this occurring range-wide? It seemed that some sort of organization could be helpful and a status-assessing meeting would be the logical first step.

Thus, the idea of a conference was born ("hatched?") and we identified possible speakers to cover various topics: population and habitat trends, land acquisition, management approaches, and reports on the programs in Wisconsin, Illinois, and North Dakota. Maertens suggested that Grady Mann, recently retired U.S. Fish and Wildlife Service wetlands manager, was the clear choice to speak on why the bird was worth caring about in the first place. Grady's slightly edited, stage-setting presentation of 28 April 1973 follows:

A SPECIES WORTHY OF PRESERVATION

On a blustery day in mid-January I received from Dan Svedarsky a letter which outlined a tentative program for a Minnesota prairie chicken conference – a conference to be held in April, 1973, at the Crookston campus of the University of Minnesota.

This to me was a particularly bright spot as it represented an important task and one, not yet (as of that date) completed for Minnesota. Today is the day that Dan was shooting for. We are here. With it, we are grateful for this leadership from the northwestern part of Minnesota, for Dan's efforts, and for his committee's actions. Long-term, I suspect that the prairie chickens will be grateful and personally, I'm grateful to this committee for the easy topic which they have assigned to me – "A Species Worthy of Preservation."

Now, just in case my conclusions get lost in the shuffle, I have shifted them to the next paragraph and they are:

1. That the greater prairie chicken of western Minnesota is a species *well* worthy of preservation.
2. That this is a species worthy of the best collective action of this group today and into the immediate future to ensure its preservation and proper management.

With these conclusions as a starting point, let me fill in to see how I worked toward them. Let me back up a little. While working from the Fergus Falls, Minnesota, field base from 1954 through 1972, it was not uncommon to hear of the frequent prairie chicken hunts via horse-drawn wagons. Much of this hunting took place a few miles west of Fergus Falls in Wilkin and Otter Tail counties. These glowing reports came from fellows who had grown up in the area, and those memories were still fresh in their minds. U.S. Fish and Wildlife Service field forces during this period worked steadily throughout western Minnesota, largely on wetland delineation, marshland acquisition, and wetland management. Through this widespread coverage we witnessed a steady disappearance of wild haylands throughout this zone. Over this western Minnesota region, shallow marshes were ditched by the thousands, and the plow advanced steadily into the existing prairie lands – prairie lands known to be occupied by prairie chickens. Ed Weiland's "upside-down prairie", continued to expand and blackened lands mushroomed across western Minnesota.

During the spring of 1955, Norm Ordal, biologist with the Minnesota Department of Natural Resources, introduced me to the widely scattered booming grounds of the prairie chicken along the beachlines of Glacial Lake Agassiz. These early trips stimulated a special interest in this species for me . . . an interest that has grown over the years. Prairie life on and adjacent to these booming grounds was a sight that could stir even the "least alert." Godwits, sandhill cranes, pintails, jacksnipe, and all the rest were certain to put on a show.

Through the intervening years it seemed that the western Minnesota prairie chicken population was hanging on not because of a major effort directed for it but because of a chain of physical circumstances which, by accident, resulted in the preservation of chicken habitat. The scattered wetland projects of the Minnesota Department of Natural Resources and the U. S. Fish and Wildlife Service, although not planned specifically for prairie chickens, had been playing an important part in their survival. However, that population always seemed on a "shaky edge."

We could see where a quote from Aldo Leopold applied when we contemplated the declining range of this species:

> *A little repentance just before a species goes over the brink is enough to make us feel virtuous. When the species is gone we have a good cry and repeat the performance . . . (Leopold 1970: 194).*

The greater prairie chicken in western Minnesota was making it . . . but it was rapidly losing ground, its range, and its possibilities for long-term survival.

Another key point: this habitat decline was happening in our own backyard — or within a few miles of it. It continued to bother me that we didn't have much of anything specifically going for it — an effort designed within which the prairie chicken would be the central figure of a preservation objective. It's true we had made token efforts. As one example I recall, for about every plan that came by for western Minnesota, Gordy Nielsen and others outlined the prairie chicken range and inserted that range as a part of those plans.

These were "hit and miss" recommendations. Yet, throughout these and other efforts, the "selling power" of the prairie chicken stood out as a key argument for preserving prairie wildlands.

By way of a sidelight, in the wildlife management field, it's often considered an important task for the U.S. wildlife investigator to head to Africa (or some other remote place) to study the threats to species in those zones. That foreign action is newsworthy, attracts a lot of attention, and is necessary for perspective. But there is something in my makeup that says, "let's look closely at what we have *right here*." Let's consider the beauty and utility of those natural resources close by. Then, inasmuch as those in the immediate area collectively know the people, the needs, and the possibilities that exist, let's proceed to handle those resources well. This brings us back to Chairman Dan's noteworthy actions of last January.

Permit me to draw upon a few personal experiences to help make my point that the prairie chicken is truly *"A Species Worthy of Preservation."*

Over the past 3 decades I have had the good fortune of spending a lot of pleasant days afield and many of those days were highlighted with observations, memories of which are exciting, spectacular, and inspirational in their own right. A few of these:

. . . *in the spring of 1949* — with Merrill Hammond on the flooded Lower Souris Refuge — recording for 6 days a record pintail flight, a pintail flight of magnitude never observed before, since, or possibly into the future.

. . . *in April of 1955* — with Morris Paterson, from the cattails of a marshy edge — watching large flocks of whistling swans against the spring winds, dropping like leaves into the White Rock Area on the South Dakota-Minnesota border.

. . . *and timber wolves* — on that cold day in January — under full chase of the white-tailed deer from back of the island on Ramshead Lake in the Boundary Waters Canoe Area.

. . . *of black ducks,* up out of the jungly, woody ponds of the Quetico Superior.

. . . *and ptarmigan,* within six feet, pecking at the sedges above the timberline in the Rockies.

All outstanding wildlife memories that were striking, memorable, and remarkable in their own right. But even with the special qualities of each of these experiences, none have topped the quality of watching the display of the greater prairie chicken on the booming grounds of western Minnesota. None of the cited cases, whether on the prairie, in the woods, or mountains, have provoked the imagination, appeal, historical significance, precarious state, and future consequences of a species, as has the "booming" of the prairie chicken. To me, if it has this attribute, as it has to many, it is just a part of our stewardship responsibility to make sure that this *species is maintained for the future.*

Today we will have a wide variety of well documented technical details provided by a base of field workers — workers with a wealth of experience and background. Information from them, combined with contributions and questions from the panel members, will give us the starting point for action of the future.

We are meeting today. More information than we can handle will come out today. To make sure that this is only the starting point, the planning committee will name an action committee (from a wide cross-section of interests) to digest the ideas, proposals, and thoughts from this conference . . . all directed to help

translate these into action — action that can be well based technically and moved administratively and politically to do the right job by this important wildlife resource.

Enough now. Back to my topic title, *"A Species Worthy of Preservation."* And my conclusions again:

1. That the greater prairie chicken of the western Minnesota range *is* a species well worthy of preservation.
2. That it is a species worthy of the best collective action of this group today and into the immediate future to ensure its preservation and proper management.

(Mann 1973)

The 1973 conference was a good meeting, attended by 100 or so enthusiasts from across Minnesota, as well as a few from North Dakota, Illinois, and Wisconsin. Al Grewe and Dan Frenzel brought a contingent of students from St. Cloud State University and the St. Paul campus of the University of Minnesota, respectively. Keith Harmon, field representative of the Wildlife Management Institute, provided the summary or the "What next?" paper at the conference. Terry Wolfe and I edited the proceedings (Svedarsky and Wolfe 1973) and distributed it to attendees, various agency offices, and libraries. A number of newspapers picked up on the excitement and ran articles; Craig Borck for the *St. Paul Pioneer Press,* John Lohman for the *Fargo Forum,* articles in the Detroit Lakes *Becker County Record.*

Andrew Malcolm, a reporter from the *New York Times,* spent a morning in a blind with Terry Wolfe and did a follow-up article. Instead of using "Crookston" as the location, he apparently thought "Climax, Minnesota" was more intriguing to list as a location for watching the courtship ritual of prairie chickens (and so the article read).

A key part of the 1973 conference was the outlining of the prairie chicken range in northwest Minnesota along with remaining grasslands, mostly native prairie. This effort was coordinated by Gerald Maertens as he gathered information from other state and federal resource managers. Geoff Barnard, Minnesota Director of The Nature Conservancy, was an enthusiastic visionary and soon proposed "The Minnesota Prairie Chicken Preserve System" to his Board which became a major initiative. Significant purchases of prairies were made in the mid-1970s by The Nature Conservancy and while prairie chickens are not totally dependent on native grasslands, they make a terrific "star of the show" for prairie biota.

After the conference and production of the proceedings, the "prairie chicken group" worked on the "What next?" phase. Sometime in the winter of 1973–74, Grady Mann and I decided to visit the Hamerstroms in Wisconsin to learn, first-hand, what had been key to the successful launching of the Society of the Tympanuchus Cupido Pinnatus. It was a memorable trip. We eventually found the Hamerstrom's large farm house and frankly thought it was abandoned until we spotted their Volkswagen van around back. No indoor plumbing, wood heat from pot-bellied stoves, free-flying raptors inside, and dust-covered, prestigious conservation awards made for a unique setting.

After a delicious evening meal, we talked into the night about wildlife research, building public and private support, and about having fun with conservation work! That was one of the keys — having fun. Fred Hamerstrom said it this way, *"Good works do not need to be done in a sepulchral atmosphere."* The annual meeting of the Society of Tympanuchus Cupido Pinnatus is basically a cocktail party with a very short business meeting thrown in for legitimacy. Some years later, I would have the pleasure of presenting an award to Fran at this annual meeting (called a *"Gathering of the Flock"*) and it was a delightful affair.

Grady and I slept upstairs in the "ballroom," which was used for dancing in the glory days of the big house built in the pre-Civil War period by the first judge of Waushara County.

We slept in the same bunks where countless prairie chicken watchers had overnighted for some 30 years. It was cold. The recent insulating was only in the floor which kept the heat downstairs! After breakfast we departed for Minnesota, memory-rich, with the assurance that the Hamerstroms would keynote the first official meeting of the Minnesota Prairie Chicken Society in the spring of 1974. They did and it was grand.

In the early organizing days, I would cross trails with many memorable people. One of these was Oscar Thorbeck. Originally from northwest Minnesota near Gonvick, I first heard from Oscar on 15 April 1974:

Dear Mr. Svedarsky

Enclosed find two checks for promotion and preservation of the prairie chicken.

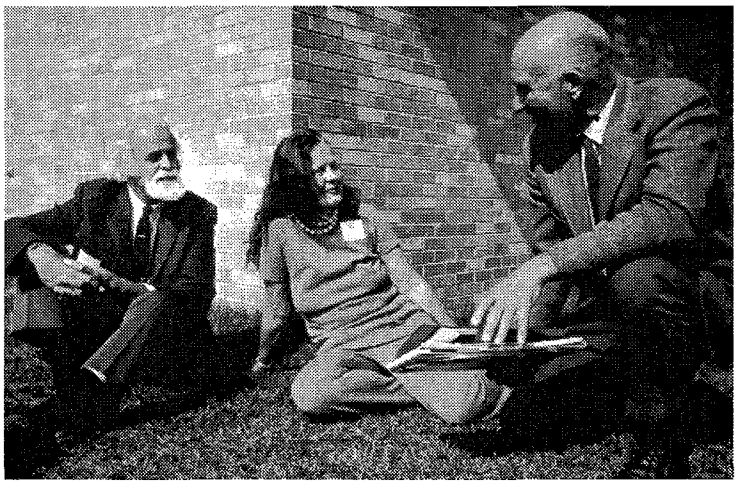
I was raised at Gonvick. I have a couple of farms up there and north of Gully. If you know of any (prairie chickens) in that area I sure would like to see one again. Last saw one in the late 50s.

Wishing you great success.

Sincerely,

Oscar Thorbeck

Oscar would become a key supporter of the budding Society and was a wonderful story himself (Svedarsky 1995). Later, in 1993, I would meet him when I launched a wildlife research project on the wild rice farm of his son-in-law, Paul Imle, near Gonvick. The man was a dynamo, with many passions – family, community, farming, sports, hunting, and, lucky for us, prairie chickens! I don't think



MPCS first president Grady Mann (right), with Fred and Fran Hamerstrom at the first annual meeting in Fergus Falls in 1974.

Oscar ever did see a prairie chicken after that first letter to me in 1974 but it was apparently enough for him to just know that they were out there and that he was helping out with their conservation.

In 1993, Chuck Vukonich of the U.S. Fish and Wildlife Service, asked Grady Mann to recount the beginnings of the Minnesota Prairie Chicken Society on the occasion of the twentieth anniversary meeting. I include the following text of that article (Mann 1998), as it captures the essence of the early years of the Society. (Grady is overly generous regarding my contributions to the effort which I liken to kicking a snowball down a hill which then took off on its own head of steam as others joined in the party.)

MPCS, IT'S BACKGROUND, ORIGIN, AND HIGHLIGHTS OF ITS FIRST 4 YEARS

It was with pleasure that I took on Chuck Vukonich's request for a recollection of highlights from the early days of the Minnesota Prairie Chicken Society. It comes down to people – those that did not let an idea die. Here goes, even at the inevitable risk of omitting many (to these my apologies).

As the prime mover of the early Society, Dan Svedarsky tops the list. His early interest, energy, direction, attention to detail, and low-key effective drive headed things down the track. Leo Kirsch, Carol Buckmann, Terry Wolfe, Al Farmes, and Al Grewe were right there in the early day formation, all the while making things move. Others assisted in many different ways: Gordy Nielsen, Bob Farmes, Arland "Bud" Anderson, Bill Marshall, Steve Oney, Karen Smith, Al Berner, Dan Frenzel, Morris Patterson, Glen Sherwood, Marv Mansfield,

Richard Pemberton, Elsie Welter, Melvin Ouse, and all the clerical personnel that kept up the flow of information.

The official start of the Minnesota Prairie Chicken Society came on 8 December 1973. From the minutes of the first meeting of the society:

> *"ORGANIZATIONAL MEETING MINUTES 8 DECEMBER 1973*
>
> *Seventeen 'prairie chicken friends' met at the Quarter Deck Supper Club on Gull Lake near Brainerd for the final organizational meeting of the 'Minnesota Prairie Chicken Society.' (Gordon Neilsen and Bud Anderson, Fergus Falls were unable to make it as their car went into a ditch on the way.) Dan Svedarsky opened the meeting by showing a film,* Prairies Should be Forever, *produced by Charles and Elizabeth Schwartz, Missouri Department of Conservation.*
>
> *The meeting was conducted by Al Farmes, acting coordinator, and Carol Buckmann was temporary secretary. Bylaws and minutes of the September meeting were distributed."*
>
> *For this new group, the title of "Minnesota Prairieland Preservation and Restoration Society" was originally suggested. This title was abandoned as it looked quite heavy and academic. Thus, in its place appeared the Minnesota Prairie Chicken Society. This name and group continues in 1993 and is thriving well after its launching 20 years ago. My compliments to all who contributed steadily and made this movement head toward stated goals.*
>
> *Elected initially as Minnesota Prairie Chicken Society officers were: Grady Mann, President; Al Farmes, Legislative Chairman; Terry Wolfe, Communications Chairman; Al Grewe, Finance Chairman; Leo Kirsch, Research and Management Chairman; and Carol Buckmann, Education Chairman.*

At this first meeting, it was agreed that members could do whatever necessary for the prairie chicken, but there should be constant Society flexibility. This, in retrospect, was a good move as it helped to prevent administrative hang-ups before getting off the ground. Inflexibility comes quickly enough with nearly all organizations.

Glen Sherwood, wildlife biologist, and at that time a Representative in the Minnesota Legislature, mentioned he would attempt to get something introduced in January but warned that this would be an off year session and doubted the necessary funds would be available. He asked that the film, *Prairies Should Be Forever,* and 1 or 2 Society representatives aid in making a presentation to the Legislature. He said the bill should include money for (1) acquisition – $500,000, and (2) management thereof.

Legislation drawn should state that acquisition and management of these areas would be in the best interests of all historical, cultural, aesthetic reasons, plus preservation of an endangered species. Representative Sherwood agreed to check into the possibilities of acquiring prairie chicken habitat under the Critical Areas Act and the Scientific and Natural Areas Act (State Parks administration). Other areas where assistance might be possible were the Great Plains Program (Soil Conservation Service) and the Endangered Species Act which could be a significant boost to the program if it gets out of Congress. So, even at the outset, realities of legislation, funds, and all problems were being met head-on; all direct moves to help the greater prairie chicken populations of Minnesota.

Not all aspects of the Minnesota Prairie Chicken Society met with favor statewide. Terry Wolfe reprinted the following from the Sleepy Eye Herald Dispatch in the April 1973 Minnesota Prairie Chicken Society Newsletter:

> *"Pure folly," says Jim.*
>
> *The status and future of Minnesota's prairie chicken will be the subject of a conference in Crookston.*
>
> *Jim Putnam, editor of the Granite Falls Tribune, thinks it's pure folly to call such a meeting. He says there has been no open*

season on prairie chickens since 1942. The population began to decline sharply as the acreage of cultivated land increased, grasslands disappeared and land owners converted their wheat fields to corn and soybeans.

Putnam said he grew up with a .410 shotgun and has never killed or even seen a prairie chicken. Said he: "We haven't seen any zebras running around the acres either. The chickens have flown the coop and the meeting at Crookston is just another reason why Minnesota taxes are among the highest in the world."

I'm not sure of the thinking in the last sentence but despite all – the Minnesota Prairie Chicken Society in 1993 moves on.

Early in the Society's work, Leo Kirsch served as research and management chairman and from that position kept all organization movement focused on the land, it's use, wetland preservation, and all natural resources essential for prairie chicken maintenance. He pointed out 2 things he believed to be of utmost importance: 1) make a concentrated effort to assess spring prairie chicken numbers through booming ground counts, and 2) intensify management of lands that were available for chicken management.

At the same 1973 meeting, Dan Svedarsky commented, ". . . Minnesota prairie chicken publicity is far-reaching. Letters have come in from as far as California and British Columbia, and quite a number have come from throughout Minnesota. There is much interest in raising and restocking prairie chickens and probably we should point out in future articles that restocking chickens is extremely difficult and that our first efforts should be directed towards securing the habitat of existing birds."

By 1974, sufficient organization had transpired to plan the first official meeting of the Minnesota Prairie Chicken Society. Al Berner was named as chairman to organize this first meeting to be held at the Fergus Falls Community College, 27-28 April 1974. As usual, when Al picked up a job to do, it was done completely. That's what he did in this case.

An MPCS field trip on a prairie ridge near Fergus Falls in 1974. Sermon on the Mount?

As a result, Al and his committee assembled many of the Wisconsin and Minnesota "big guns" for the program. Fergus Falls Mayor Tom Donoho, Minnesota DNR Commissioner Robert Herbst, Drs. Fred and Fran Hamerstrom, and Steve Oney of The Nature Conservancy were all there. Clarence Swenson from Fertile, Minnesota, presented interesting accounts with his reflections from the past. And always, the early morning tour of the booming grounds to keep foremost in member's minds the reasons for all the human activity.

Goals of the Society were clarified in the 1974 Newsletter:

The primary purpose of the Society will be to engage in and encourage all activities of benefit to prairie chickens, including management, research, education, and land acquisition.

GOALS OF THE SOCIETY INCLUDE:

1. Increase public awareness of prairie chickens and their natural habitat requirements.

2. Support efforts to preserve prairie chicken habitat.

3. Encourage State and Federal land management agencies to reestablish prairie chickens upon their lands after grassland habitat has been restored.

4. To develop and disseminate information to private land holders concerning methods by which grazing and cropland management might be modified to benefit prairie chickens.

5. Undertake and support legislation that would favor the above goals.

Research and management chairman, Leo Kirsch constantly cautioned that although a considerable acreage of grasslands had been acquired in Minnesota, there was no cause to feel at all complacent about the security of chickens. Leo went on to outline the fate of chickens on several national wildlife refuges where they disappeared because of lack of proper management. In eastern refuges, plant succession eliminated chicken habitat and in the western refuges, grazing and mowing and plant succession diminished the proper habitat.

To keep track of the prairie chicken populations, a booming ground census of male prairie chickens was completed in the spring of 1974 throughout the Minnesota range. In a cooperative effort between the U.S. Fish and Wildlife Service, the Department of Natural Resources and a number of college people, 72 booming grounds were located. Approximately 873 birds were counted for an average of just over 12 prairie chickens per booming ground. Booming grounds were found with sometimes only I or 2 birds, but over 30 birds on 1 area.

The editor of the fall 1974 edition of the Society Newsletter had obvious pleasure as he reprinted an exuberant notice from the Minnesota office of The Nature Conservancy. He reprinted it untouched:

HURRAH!!! HURRAH!!! HURRAH!!! HURRAH!!!
ANNOUNCEMENT

Alack! Brethern and Cistern, Praise and be praised! The winged dove, the white messenger hath descended with the news! We've DONE IT! The fund drive is completed. Yep, that's right. In less than one year. Yes siree! Let the heavens open, let the thunder roll, let the skies abound with a resounding sound, let the valleys echo, let the good times roll. Turn up the volume on your hi-fi. Let the multitudes rejoice in all manner and form of hoopla!

HURRAH!!! HURRAH!!! HURRAH!!! HURRAH!!!

The newsletter editor followed up this unusual notice with these comments:

And rejoice they should for in setting out to raise $309,362, the Minnesota Chapter raised $326,269.55! (And that ain't hay... Well, prairie hay maybe). This pays for a lot of prairie chicken habitat which The Nature Conservancy has acquired throughout the range and other unique natural areas in Minnesota.

One of the most significant contributions was from Katherine Ordway for the 1440-acre Pembina Trail Preserve in Polk County. This beautiful expanse of aspen parkland and prairie is situated on a beach ridge of glacial Lake Agassiz and provides habitat for prairie chickens, yellow rails, marbled godwits, prairie orchids including the white fringed, and a variety of other prairie treasures. A 1-mile segment of the historic Pembina Trail is also located on the east edge of the Preserve.

This effort is most timely due to rapidly inflating land values. Field workers report the doubling in price of prairie lands in 1 year to say nothing of the decreasing supply of prairie. It's going under plow discouragingly fast.

Great work, Geoff Barnard, Steve Oney and staff of the Midwest Office and to the Minnesota Chapter. You're a great bunch of hustlers!

From the 1974 inaugural spring meeting these especially noteworthy quotes were recorded:

- "In no way can I be complacent about the status of the prairie chicken in Minnesota. There were probably more chickens in eastern North Dakota 10 years ago than there are in Minnesota today. These virtually vanished in 10 years, and there are probably no more than 300 to 400 chickens in North Dakota today." Leo Kirsch, Woodworth, North Dakota.

- "Prairie chicken fascination? People from New York or other states in the east have come in large numbers (to the Rothsay area) to watch prairie chickens since at least 1945." Melvin Ouse, farmer, Rothsay, Minnesota.

- "Prairie Chicken War! Some years ago, small town politicians attempted to run us out of the country. It was stated by politicians then, 'All you need to save the chickens is get rid of the Hamerstroms and the foxes!' " Fran Hamerstrom, Plainfield, Wisconsin.

An executive board meeting was held at St. Cloud State College — 1 February 1975. Leo Kirsch, research and management chairman, remarked, "The only way to keep a finger on the pulse of the population is to keep up the booming ground surveys." Wildlife personnel would be involved in the 1975 count to take place from late March through April and into May.

Other highlights of this 1975 meeting follow:

- Some members wanted to see a fall population figure projected from the booming ground census but a discussion indicated that wide discrepancies would be inherent in any projected population figure. It was decided to report only the number of birds counted on booming grounds.

- The second major goal of the research and management committee was to encourage more intensive management of agency and The Nature Conservancy lands. Kirsch noted that the major problem on these lands now is plant succession and fire is the cheapest and most effective tool to deal with it. Morris Paterson mentioned that a lot of groundwork is necessary to carry out a controlled burn. State Forestry, weather and local people must be reckoned with.

- Dan Frenzel suggested that certain areas be studied to note changes in plant succession and relate these to changes in bird numbers. Booming grounds can change from year to year in location and occasionally birds break into smaller groups. As management intensifies we should note gross changes in chicken numbers.

- An excellent drawing of a prairie chicken was made available to the Society by Karen Smith of the Fish and Wildlife Service. This was used as a means of fund raising by selling prints, note cards, and belt buckles.

- In a review of overall goals of the Society, it was noted that the Society was making progress on nearly all goals. Overriding concern at this time should be to stop the downhill slide of prairie chicken numbers in Minnesota. Dan Svedarsky, Dan Frenzel and Terry Wolfe were to review the Society goals and offer suggestions for changes.

- In 1974, Svedarsky commenced a 3-year study of nesting and brood-rearing ecology as it related to habitat use and equipped females with radio transmitters to follow movements. The principal study area was the 1440-acre Pembina Trail Preserve of The Nature Conservancy with several DNR prairie tracts located on the periphery. Controlled burning in particular would be evaluated on these tracts as a means of managing grassland nesting and brood-rearing habitat.

Dan Svedarsky did not go to another part of the world for his research. If not in his own back yard, it was the next thing to it. The title of his project was *Spring and summer ecology of female greater prairie chickens in northwestern Minnesota.* By radio tracking he was able to accurately pinpoint uses of various habitats by the chickens. A few greatly abbreviated points from the summary of his Ph.D. dissertation (Svedarsky 1979):

1. Lowland areas dominated by sedge are preferred roosting sites.
2. Trees appear to serve as raptor ambush perches.
3. Any practice safeguarding early nests would likely benefit reproduction since those chicks tend to hatch before the annual precipitation peak.

As a sideline to this intensive field research, Dan was singled out as a key contact as one who knew specific points about prairie chickens.

We met in the field once. While looking over his study area it appeared that Dan was little more tense and harried than his usual self. But with a full teaching load and long, irregular hours of field research, this was to be expected. The key factor of his tenseness was none of these. The big one? His field project kept him constantly in the field. As Svedarsky conducted his research, he was observing on all edges of the Agassiz beach-line the steady encroachment and loss of similar habitat; the same habitat he was doing his field studies on. This was the key factor taking its temporary toll.

This incident is mentioned as an example of the pressure that all field men have to deal with. That's the way it is with all major resource issues. As you move ahead on your preservation duties, you note losses here and there. But out of it all, you do what you can, where you are, with what you have, and do the best you can with it.

The summer "Brood edition" of the Minnesota Prairie Chicken Society Newsletter (July 1975) summarized highlights from this second annual meeting of the Society. A few of these follow:

- Max Partch of St. Cloud State University was elected President of the Society. And Max, in true Partch style, coined a phrase, *"Ask not what the prairie chicken can do for you, instead ask what you can do for the prairie chicken."*

- Steve Oney, of The Nature Conservancy, offered much philosophy after working with prairie acquisition in northwestern Minnesota. Steve observed, *"The ship of the prairie has already sunk – we are just trying to save a few of the life boats."*

- The Nature Conservancy had not given up by any means though and were fast forging ahead. As Steve said, *"We're still looking for a few good prairie chickens."* In looking for chickens, they bought the 240-acre Audubon Prairie[1] made possible through a grant by the National Audubon Society, took an option on the 720-acre Burg Prairie near Buffalo River State Park, and were making contacts on other tracts throughout the prairie chicken range.

- Of course, not all is roses in land acquisition work. Steve told of one 320-acre tract he once tried to buy. With no luck in acquisition attempts, he watched as many thousand years of nature's work was lost in 1 year - the prairie was plowed last fall.

- Grady Mann, outgoing president of the Minnesota Prairie Chicken Society, reviewed Society activities of the previous year. He noted how just increasing people's awareness of prairie chickens has had beneficial effects. As he quoted, "It is easy to beat a drum for protection of some distant form of wildlife, but not easy to enthuse people to protect their own local troubled wildlife."

On the subject of controlled burns, newsletter editor, Terry Wolfe provided an excellent summary:

> *No doubt one of the most important management techniques to benefit prairie chickens is controlled burning of grasslands. This does not mean the wholesale burning of all available winter and nesting cover on an annual basis. It does mean a rotational type burning where a portion of the grassy cover is burned each year in a local area. The rest is left for nest cover.*

[1] *Editors' note: The Audubon Prairie purchase was instigated by Minnesota DNR Wildlife Manager Terry Wolfe contacting the regional office of National Audubon and inviting them to do something to join the prairie chicken parade. They did respond.*

Fires and prairies have always been natural partners. Prairie fires maintained the prairies. This is especially true in much of Minnesota where brush and tree encroachment could soon have eliminated the prairie if it wasn't for fires. Prairie chickens are adapted to prairie burning – it has always been a part of their way of life. Fire has the following effects:

- *Controls brush and timber encroachment on prairies. Notice the word 'controls'; fire doesn't completely eliminate brush and trees – it keeps them down in height, so that the prairie is open.*

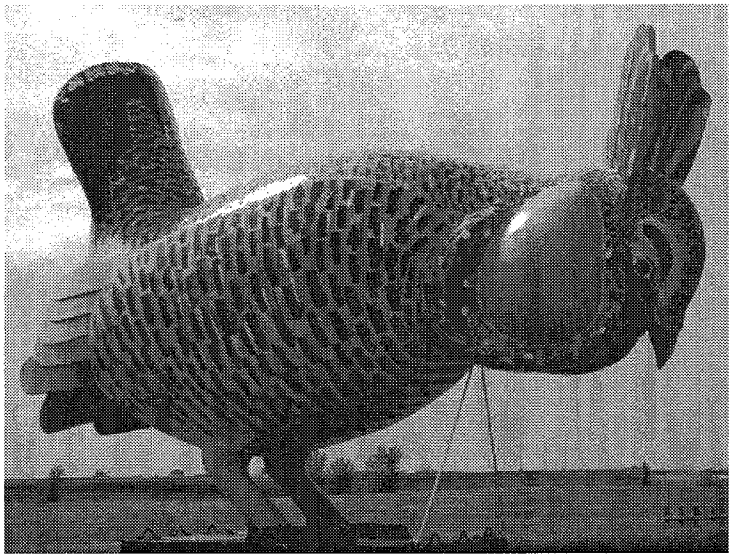
- *Stimulates seed and berry production. We pick strawberries and raspberries on burned over areas that formerly produced mostly stems and leaves, but few berries. Seeds and berries are high in food value and provide food for a wide variety of wildlife.*

- *Removes grass and leaf litter which covers the ground, reducing stem density and ties up nutrients. With litter removal the ground warms up more quickly in spring and 'green-up' occurs earlier. Nutrients are readily available.*

- *Provides 'edge effect.' Frequently, prairie chicken nests occur near field edges or boundaries of roads, clumps of brush, etc. This seems to be true of other nests as well.*

- *Also reduces wood ticks – an observation recently related to me by an amateur botanist who discovered this while observing wild flowers on a spring-burned wildlife area."*

The fall edition (October 1975) of the Minnesota Prairie Chicken Society Newsletter noted that, " the Rothsay Bicentennial Committee extended an invitation for the Society to hold its annual meeting in Rothsay next spring in conjunction with an official dedication of the town as the 'Prairie Chicken Capital of Minnesota.' Local townspeople are constructing a new chicken that may be 15-20 feet high that will be displayed along the exit from Interstate 94. An excellent way to help get the chicken on the map! (Can you imagine the boom that would issue forth if prairie chickens were really 15 feet tall? That would be enough to rattle dishes and crack windows 10 miles away!)"



The "big chicken" at Rothsay, Minnesota. The community lays claim to the name, "Prairie Chicken Capital of Minnesota."

Editor Terry Wolfe also included the following in the October 1975 Newsletter:

We are reprinting the following letter which we received from John Lasniewski. It warmed our heart and thought it would yours, too. Mr. Lasniewski is in his eighties and donated the first dollar to the Society.

August 10, 1975
Greenbush, Minnesota

Thanks a lot for sending me the prairie chicken pamphlet – nice and interesting information and reading.

Tho [sic] I am too advanced in age to play an active part, am enclosing one hundred pennies to prove that I am still one hundred percent for restoration of the prairie chicken population, altho [sic] there are none left here no more, where they at one time were numerous. I wish I once could see and hear them again.

Yours for a grand success in your venture in restoring the birds.

John Lasniewski

The Bicentennial dedication of Rothsay as the "Prairie Chicken Capital of Minnesota" highlighted the third annual meeting of the Minnesota Prairie Chicken Society, and was held on 24 April 1976, at the Rothsay High School.

Commissioner Robert Herbst of the Department of Natural Resources, made the dedication, commenting on Rothsay's welcome commitment "to one species in Minnesota." He noted how interest in prairie chickens is growing again in Minnesota after wildlife managers in 1942, with a closing of the hunting season, had given up on them. The increasing number of people coming to watch prairie chickens every spring was also noted. Herbst thanked the Rothsay people for their firm support and interest, and stated, *"We have a good start, I hope you will continue the commitment."*

U.S. Congressman Bob Bergland also spoke at the dedication and addressed issues of wise land use; good soil conservation, grass on erodible soils, healthy wildlife populations, and prosperous local communities. Bergland would later be named Secretary of Agriculture.

The internal anatomy of the 'great chicken' was shown with photos in the April 1976 Minnesota Prairie Chicken Society Newsletter. Guts of the 'big chicken' were a maze of wire, rods, and welding – all the result of careful planning and workmanship. Its chief architect was Art Fosse and the other chicken creators were Randy Weise and Alan Haugrud; truly a work of art. Since its completion the big chicken has attracted untold numbers of curious visitors and tourists through the area. My compliments to the builders and the thoughts that prompted this symbol.

The "Boomer Award" was presented to Dan Svedarsky for his "undaunted efforts to find the last chicken" during spring booming season counts. As Rollin Siegfried, who prepared the traveling trophy, noted, "This award is presented to the individual who has shown a determined effort to census all known prairie chicken booming grounds; hence the name of the award – 'Boomer' or perhaps it should be more aptly named the 'Bummer Award.' The individual receiving the award this year has been consistently late for meetings. He explains his tardiness by mumbling such phrases as, "I got stuck," or "I ran out of gas." We were going to present him with a gas can but for some reason we could not imagine him displaying that type of award on his office wall."

On a more serious note, Steve Oney, Field Representative for the Minnesota Chapter of The Nature Conservancy, commented in a 1976 Society newsletter:

> *In 1972, the Conservancy embarked on an active campaign to secure tracts of native prairie along the ancient beachline of Glacial Lake Agassiz to protect critical habitat needed for the greater prairie chicken's survival. The population of prairie chickens in Minnesota has dwindled from literally millions to just 3,000 birds, according to the 1975 state census. Working with the Minnesota Prairie Chicken Society, concerned local citizens, and with the help of the Minnesota Department of Natural Resources, the Conservancy has acquired over 6,000 acres of prairie within the range of the prairie chicken. Purchase of the Blazing Star Prairie Preserve with a $25,000 grant from the Red River Valley Sugarbeet Growers Association (coordinated by Al Bloomquist, Executive Director) is an outstanding contribution from the residents of Clay County towards preserving a part of the county's own natural heritage.*

Now, by date, my highlights are outside the limits of the "early days" of the Minnesota Prairie Chicken Society – up to January 1977 – 4 years since its official start on December 8, 1973. It is fitting that I close with 2 points:

First, a direct challenging letter by Max Partch, President of the Minnesota Prairie Chicken Society, to Bob Bergland, who had just been named Secretary of Agriculture. Partch's letter in the January 1977 Society Newsletter was thought provoking and hit strongly on land use:

> *Chickens, Grass, and Snirt – an open letter to Bob Bergland, the new Secretary of Agriculture*

Congratulations on a most deserved appointment. With a great deal of pride, we remember your welcome to all those assembled last spring when Rothsay was designated as the Prairie Chicken Capital of Minnesota. That group represented a mixture of land-use preferences all drawn together on that occasion by a common interest in prairie chickens. Prairie chickens need grasslands. The land needs grasslands.

The headlines that spanned the front page of the St. Cloud Daily Times for 20 December 1976, said, "Bergland tapped for cabinet." The headlines of the adjoining article stated, "This winter looks bad for snow, but fine for snirt." Yes, some land needs grasslands.

We have read that you are a vigorous exponent of the family farm, a conciliator of competing agricultural interests, and that you are aware of the vagaries of weather and its devastating impact. You recently asserted that the big issue before the nation is global hunger but you also said that you do not believe that the United States can feed the world. We agree. All these things suggest that there may be more to rural life than maximum production.

Man does not live by bread alone. The quality of life depends on more than black dirt from fence to fence.

You have promised to be a farmer's advocate. The decisions you make in the years ahead will be many and difficult. We of the Minnesota Prairie Chicken Society hope that in some of your decisions you can also be an advocate for the total landscape where farmers live. In prairie areas, we believe that native grasslands added to the quality of the landscape, and that the prairie chicken may be an index to the health of that landscape.

Even with the chance of sounding like a heretic, completely out of touch with reality, I will predict that when horses again tend to replace the large gas-guzzling behemoths, then more grasslands will return, farming will be a way of life and not just an industry, and man will be in better harmony with his environment.

What does it profit a man if he gains the whole world market and loses his own soil? Mr. Secretary, we wish you well. You have our support in the task ahead.

Max Partch, President,
Minnesota Prairie Chicken Society

And last, a few additional thoughts: What does all of this attention to the greater prairie chicken mean?

It means that the prairie chickens know – as you and I know – that they conduct their booming rituals on only a bare remnant of the prairie land that existed less than a century ago. This ancient ceremony pricks our conscience. It pricks our conscience because it is symbolic of our Nation's broader land use and environmental issues.

Issues . . .

- that question whether we have plowed all too many lands, lands that should never have been disturbed early in our history, or even now.
- that question whether we have drained all too many vitally important potholes and marshes – losing not only their margins and essential values but making intervening uplands vulnerable to the plow.
- that recognize diversity on the land is being lost; and that means lost diversity of bird and animal life.
- that remind us, via this ancient ritual, that we are adapting many land management priorities to machines rather than to natural long-term capabilities of the land.
- that, in all too many cases, *greed exceeds need* – as we manage land and other resources for short-term gain rather than long-term survival.
- that the strict principles of stewardship are often lost, or at best, shoved farther and

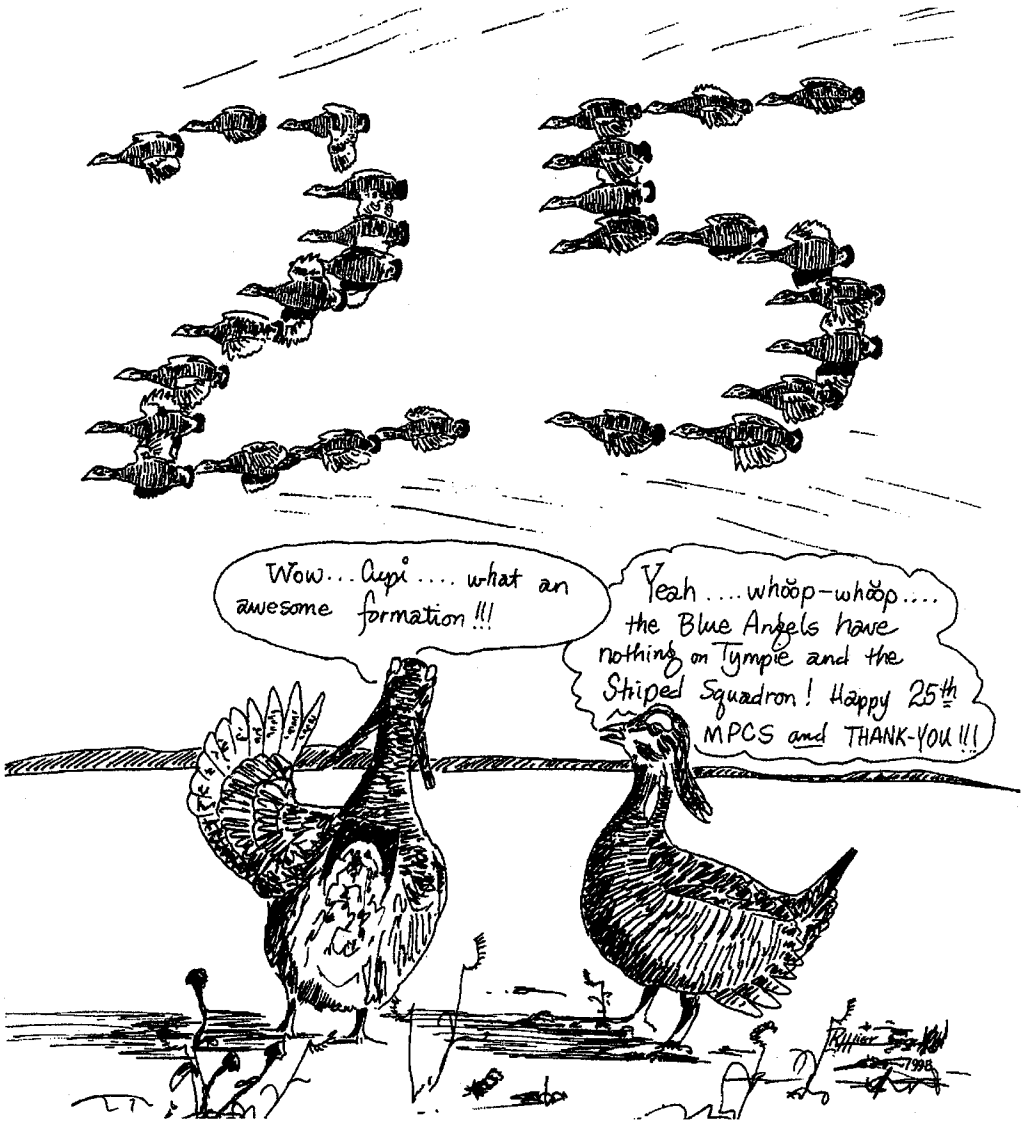
farther into the background.

With these closing comments, trips to the booming grounds of the greater prairie chicken provide not only a viewing of an ancient ritual, but a strong reminder (with a few moments on prairie sod) that we all have major responsibilities for the land, the water, and the total environment.

That's why we are here.

(Mann 1998)

Over the years, the Society's practice has been to rotate the annual meeting's location to increase the visibility of the organization, bring it occasionally closer to all of the membership, and sponsor field trips in local areas to develop a familiarity with state-wide habitat conditions. Commencing in 1976, with the dedication of Rothsay as the "Prairie Chicken Capital of Minnesota," the Society meets there about every 5 years and at least 1 board member is from Rothsay. Roberta Ouse, Janice Rudh, Art Fosse and Richard Lysne have all assisted from the community which has developed unique prairie chicken T-shirts,



pins, post cards, caps, place mats, and a small version of the giant prairie chicken statue that is taken on a trailer to area parades.

A variety of memorabilia and art work has been produced for fund and fun raising at annual meetings. Karen Smith, artist/refuge manager from Kenmare, North Dakota produced the first original prairie chicken print for use by the Society. Others have included donated paintings by the Wisconsin artist Jonathan Wilde, the Minnesota artist/wildlife manager/Society vice president – Ross Hier, and the wood carver/wildlife manager/Society treasurer, Earl Johnson who also implemented a collector belt buckle project featuring the Karen Smith chicken. Typically, each community hosting the annual meeting develops a unique T-shirt, pin, or cap to commemorate the event.

Essential to the continuity of any organization that meets infrequently is a newsletter of some sort to maintain communication, give notice to the membership that all is well, and provide tangible evidence of what folks are getting for their money! It is lots of work to produce a quality newsletter that is timely. In recent years, the newsletter has attained a new level of quality under the editorship of Peter Buesseler, Minnesota Department of Natural Resources Prairie Biologist.

Harold Dubbert, retired Fish and Wildlife Service biologist, has a penchant for history and digs up obscure and fascinating historical articles which present glimpses of the early days of chickens on the prairie. Ross Hier, a frequent contributor of articles and prairie chicken art work has developed several clever cartoons to adhere to Fred Hamerstrom's admonition about good works not needing to be conducted in a sepulchral atmosphere!

And the group is a diverse bunch. Few organizations, that I am familiar with, have such a broad spectrum of members – farmers, professors, housewives, photographers, teachers, wildlife managers, writers, artists, welders, bird propagators, students, medical doctors – all drawn to a plump prairie bird that lives in a rich landscape and does a funny dance in the spring.

In addition to annual meetings, a newsletter, and support of related prairie conservation efforts, the Society sponsored the production of a slide-tape program in 1985 which was made available to schools and agencies at cost. A general information booklet on prairie chickens was also produced and distributed free to the general public through agency offices. Three environmental education "trunks" loaded with props crafted by Ross Hier and naturalist, Joe Gartner, have been sponsored by the Society for use in Minnesota and North Dakota. The Society coordinates watching of the spring courtship dance from observation blinds at Bluestem Prairie east of Moorhead and hosts visitors from across the country. A number of equipment items for prescribed burning have been donated to agencies and University groups to assist in getting the critical habitat management work done. Another major task coordinated by the Society is the annual booming ground census, the official "pulse taking" to see how the population is doing.

Society president, Brian Winter, has been instrumental in bringing the Society up to a another level in recent years. His enthusiasm, natural history and organizational savvy, and sense of humor have been key. He facilitated the Society attaining tax exempt status in 1995 which paved the way for donations to be officially tax-exempt, resulting in a significant increase in donations. With additional funds in the treasury, the Society was able to encourage and partially support prairie chicken research and restoration. John Toepfer and his students have been coordinating research on winter prairie chicken ecology and restoration/transplant research in Minnesota, North Dakota, Wisconsin, Nebraska, and Illinois. More recently, Toepfer's work has been sponsored by the Wisconsin Society of Tympanuchus Cupido Pinnatus.

At this writing, the Minnesota Prairie Chicken Society has a $60,000 grant proposal in the final approval stages with the Minnesota Legislative Commission on Minnesota's Resources and is likely to be funded in late spring of 1999 with funds available on 1 July 1999. This project would fund the restoration of prairie chickens to the Upper Minnesota River Valley

area including the Lac Qui Parle Wildlife Management Area and the Big Stone National Wildlife Refuge of western Minnesota. The Society has truly come of age in its 25-year history.

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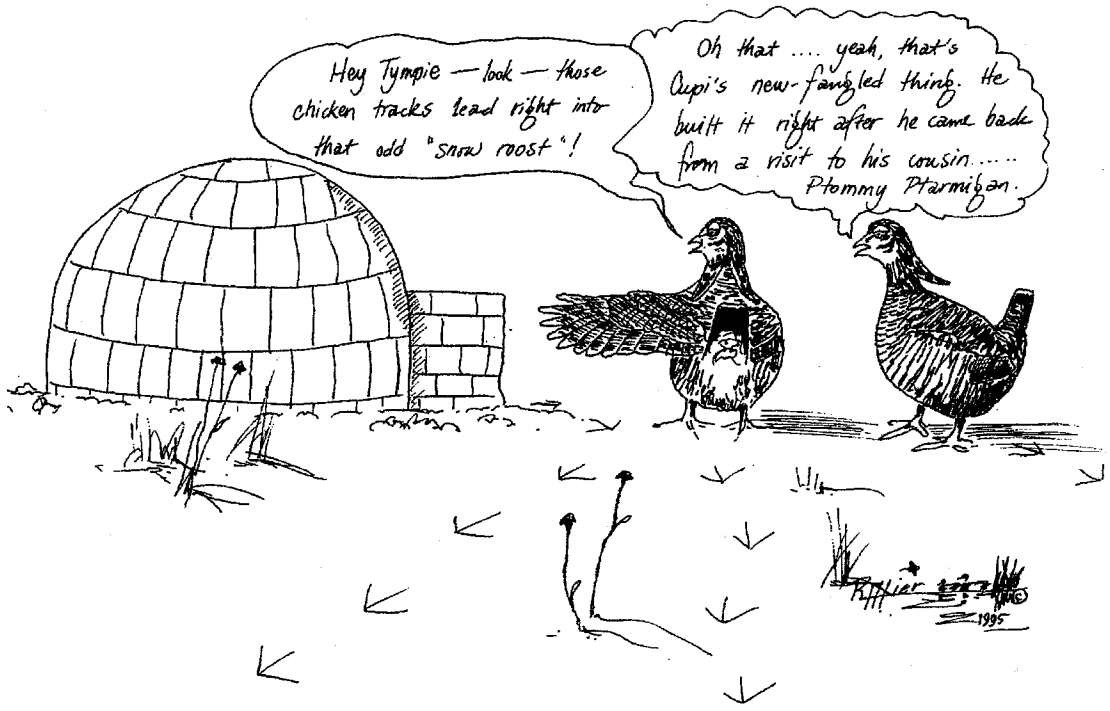

Status and Management of the Greater Prairie Chicken in Minnesota

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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 1800s (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." Breckenridge (1998) watched 3-4 males on a small booming ground in the spring of 1929 only 6 miles (9.6 km) southeast of the Metrodome in downtown Minneapolis. This is incredible to imagine today with the extent of development. Later, "well into the 1940s," Breckenridge took ornithology classes to watch chickens on a "much larger booming ground" at the Carlos Avery Wildlife Management Area 15 miles (24 km) north of St. Paul. Spreading urbanization, and the attendant increase in people, pets, buildings, fire control, tree plantings, etc. eventually displaced these remnant populations. Prairie chickens apparently persisted in the Minneapolis-St. Paul area for about 100 years.

As agriculture moved northward onto the prairies, so did prairie chickens at the rate of about 10 miles (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 primarily responsible for a steady reduction in the prairie chicken range

[1] *Revised and updated from Svedarsky et al. (1997).*

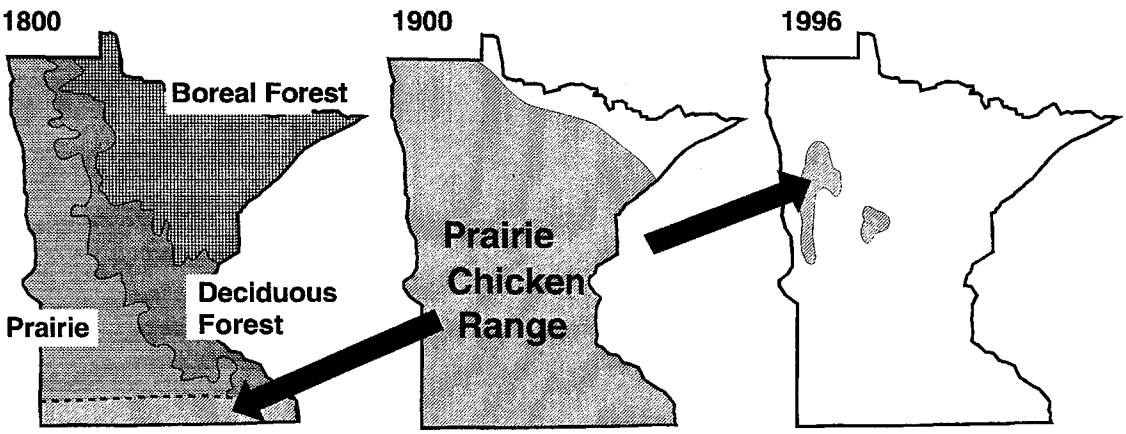

Figure 1. Presettlement vegetation and approximate prairie chicken range in Minnesota at selected times.

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 1960s 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.

In the early 1970s, high grain prices coupled with relatively low prices for prairie land ($100–150 per acre [$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 1980s and the enactment of the 1985 Farm Bill with its "sodbuster" and "swampbuster" provisions. This penalized 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, isolated (separated by 70 miles [112 km] and a zone of deciduous forests and lakes from the main chicken range) population of prairie chickens also persists in the mostly forested, north central part of the state (Fig. 1). 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).

POPULATION TRENDS

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 1800s and early 1900s. Harvest data collected by the Minnesota Department of Natural Resources (MNDNR) from 1921-50 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 1930s, 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 1930s and early 1940's (R.E. Farmes, MNDNR, personal communication). Erickson and Petraborg (1952) reported the earliest attempts to *systematically* census prairie chickens were in Norman County in 1941 and 1942 when 13 booming grounds with a mean of 11 males were counted each year. They also noted 399 rural mail carriers recorded prairie grouse along mail routes in northern Minnesota. In March of 1946, 1 prairie chicken was observed per 205 miles (328 km) traveled and 1 sharp-tailed grouse (*Tympanuchus phasinellus*) per 134 miles (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" (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 1,648 and 1,913 spring males in 1982 and 1992, respectively (Fig. 2). Swanson (1940) summarized prairie chicken abundance periods for the late 1800s 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 1951, 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

Table 1. Calculated harvest of prairie chickens and sharp-tailed grouse in Minnesota, 1921–50. (Adapted from Erickson and Petraborg 1952).

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

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

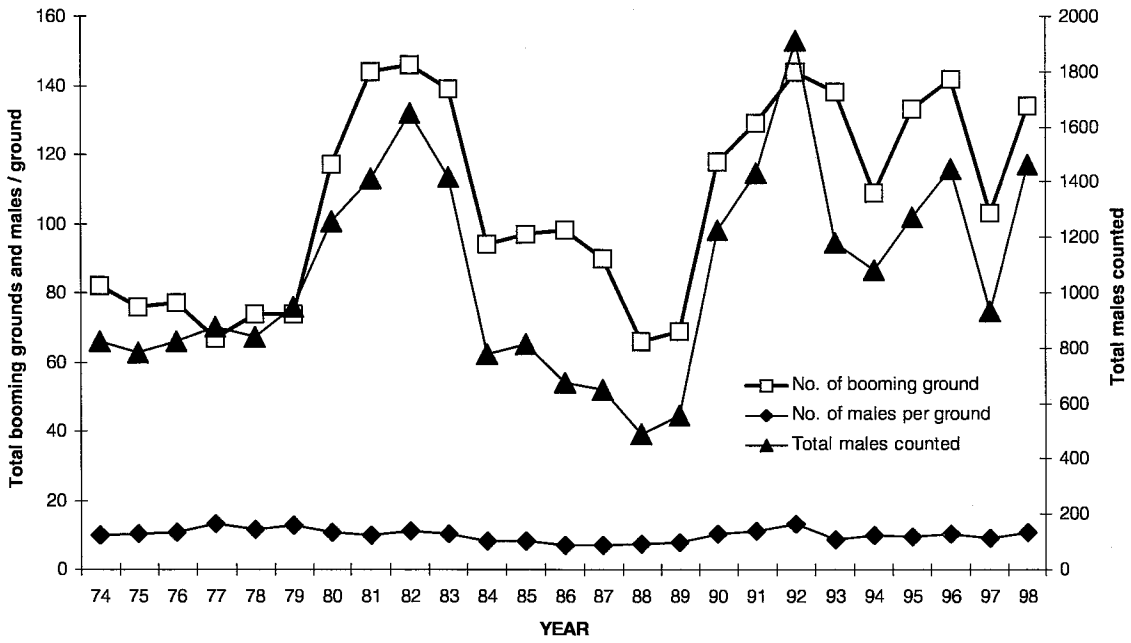

Figure 2. Total prairie chicken booming grounds and mean numbers of males per ground in relation to total males counted statewide, 1974–98.

(Fig. 2). The statewide counts parallel those in a Polk County study area near Crookston which has been intensively censused since 1974. The approximate spring density in the Polk County area ranged from about 1 male per section (2.6 km^2) overall or 1 per 62 acres (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 (Svedarsky et al. 1997).

The number of booming grounds per year tended to vary more than the average number of males per ground (Fig.2) and was more correlated with the total number of males censused (r=0.89 vs. r=0.57). The mean number of males per booming ground for the 25-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, The Nature Conservancy, personal communication.)

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 MNDNR was launched, and by 1973 there were 24,107 acres (9,760 ha) of state wildlife management areas in the northwest prairie chicken range (Nielsen 1973); these totaled 39,515 acres (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 31,784 acres (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 were grassland habitat useful to prairie chickens and other wildlife.

The Nature Conservancy (TNC) began purchasing land of natural uniqueness in the late 1960s 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, MNDNR, USFWS, and TNC had acquired 80,939 acres (32,769 ha) of habitat in the northwest chicken range and continue to do so but at a slower rate. These lands are complemented by approximately 148,200 acres (60,000 ha) of erosion-prone lands which were in grass cover in 1996 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 494 acres (200 ha) of brushland were converted to grassland and 1,976 acres (800 ha) were acquired for prairie grouse from 1990 to 1993 (Rob Naplin, MNDNR, personal communication). The future of this prairie chicken population is closely tied to private land-use practices unless more public lands are designated and actively managed as prairie chicken management units.

TRANSLOCATION PROJECTS

Minnesota has been involved in 4 prairie chicken translocation 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 (Toepfer 1988). Three releases of pen-reared prairie chickens from the MNDNR Carlos Avery Game Farm were made from 1977–80 at the Lac Qui Parle Wildlife Management Area in extreme west central Minnesota (Arlin Anderson, MNDNR, personal communication). 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 dur-

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

Ownership	1973 [b]	1983	1996
Minnesota Department of Natural Resources	24,117 (9,760)	31,135 (12,600)	39,531 (15,998)
U.S. Fish and Wildlife Service	6,820 (2,760)	14,332 (5,800)	31,797 (12,868)
The Nature Conservancy	1,048 (424)	6,683 (2,300)	9,644 (3,903)
Conservation Reserve Program	0	0	148,260 [c] (60,000)
Total	31,985 (12,944)	52,150 (20,700)	148,260 (92,769)

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

[b] *From Nielsen 1973.*

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

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

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. Birds translocated to Illinois included a radioed hen and her pair of 4-week old male chicks.

Both the Illinois and North Dakota translocation efforts have yielded positive results. The Illinois population has increased as has the egg hatchability rate (Westemeier et al.1999) In North Dakota during April 1996, 5 booming grounds totaling 23 cocks were located within a 5-mile (8 km) radius of the original 1992 release site. Two grounds had 7 and 9 cocks while several smaller grounds had 2–3 cocks. All booming grounds were within 1 mile (1.6 km) of a previous year's release. In the spring of 1998, 12 booming grounds with 83 males were located in the release area.

Since 1992, 360 prairie chickens have been released in North Dakota; 140 originating from Minnesota. Most were captured on booming grounds and translocated during the breeding season to the 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 birds 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 1990s. 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. 2).

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 translocation study of John Toepfer and his students was initiated and included studies on the winter and reproductive ecology of prairie chickens in both states and their use of CRP lands (Beringer 1995, Rosenquist 1996).

Census Procedures

Although some booming ground counts were conducted in the 1950s and 1960s, the most thorough effort to census the northwest range was commenced in 1974 by the MPCS and is on-going. Cooperators included MNDNR, 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). Also, the census areas of the Crookston and Buffalo River State Park Christmas Bird Counts include 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 (Minnesota Conservation Department 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. However, many biologists feel 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, MNDNR, personal communication). 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 over-harvest of isolated habitats, adverse pub-

lic 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. Booming ground census data are used by the Minnesota State Planning Agency (1998) as a general indicator of the "amount and health of native prairie and other grassland." Similarly, sharp-tailed grouse are used as an indicator of brushland health.

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 MNDNR, 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 MNDNR, TNC, and nearby educational institutions; particularly, the Science Center of Moorhead State University. At present, the field office of TNC coordinates viewing from blinds on a reservation basis.

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 16.5 foot (5 m) high prairie chicken statue along Interstate 94. An interpretive kiosk could be developed at this site.

The Minnesota Prairie Chicken Society (MPCS) was organized in 1974 to promote the prairie chicken through educational programs and support management and research projects (Svedarsky 1999). 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. Three prairie chicken learning trunks were sponsored for use with educational groups and events in Minnesota and North Dakota. Prescribed burning equipment has been donated to agencies and university personnel for habitat management. The MPCS has been actively involved in fundraising to co-sponsor field research and translocation projects. In 1999, a $ 60,000 proposal to sponsor the reintroduction of prairie chickens to western Minnesota is under consideration by the Legislature and funding appears likely.

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; MNDNR (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 ($\bar{x}$=370 acres [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 summer when movements are reduced.

More recently, Toepfer (unpublished data), in a continuing long-term prairie chicken ecology study, found that of 289 prairie chicken nests in western Minnesota, 66.1% were 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 generally 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 rarely used by hens for nesting in contrast to fields dominated by brome or brome/alfalfa. Native grasslands support a greater diversity of species but may include patches of non-native species as well.

The pattern of more nests but lower nesting success in CRP grasslands has been consistent 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 produced a greater portion of young. The management potential of the approximate 148,00 acres (60,000 ha) of CRP land within the chicken range is significant; it is double the combined acreage of MNDNR, USFWS, and TNC lands (Table 2), but habitat values tend to generally decline about 5 years after establishment unless it is managed. Svedarsky et al. (1998) supported increasing the species diversity of CRP plantings but also the implementation of a 4-year rotational disturbance program using burning, grazing, haying, and mowing; in that order of priority. Prescribed burning is currently allowed on CRP land in Minnesota but rarely practiced due to limitations in manpower, expertise, and equipment.

Preserved grasslands may exist as "habitat islands" within intensive agriculture. This likely increases 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 (1974–84). 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. Sargeant et al. (1995) found a hatch rate of only 8.6 % for 156 waterfowl nests on waterfowl production areas in west central Minnesota from 1987 to 1990. This included the southerly portion of the prairie chicken range. On comparable experimental areas with intensive predator control, they found a hatch rate of 15.4 %, which was at the low end of the 15–20% threshold considered minimal to maintain population stability for the waterfowl species in the study. They concluded that, even with predator control, predation of ground nests can be quite high where there are diverse mammalian predator communities present.

Since predator control programs can be difficult, costly, and often have low public acceptability, predator management through habitat manipulation is generally more desirable. This can include cover management to provide good chicken concealment, reduce litter accumulation (and possible associated predator attraction), and impede predator travel; re-

moval of denning sites such as rock piles, old buildings and bulldoze 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. Svedarsky (1979) found raptor-killed, radio-tagged prairie chickens associated with trees and suggested their removal in areas where prairie chicken management is a priority. Because it is difficult to kill trees over 5 inches (12.5 cm) dbh 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 and in winters with significant snow cover. 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, but must be cost-effective and environmentally acceptable. Burning in combination with rotational grazing is currently under investigation and appears to have significant potential as another management tool.

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. If these areas are large enough to hold coyotes (*Canis latrans*), fox predation could be reduced (Larry Hanson, USFWS, personal communication). Svedarsky (1992) found apparent success of ground nests in a study area near Crookston increased from 8% (n=12) in 1991 to 61% (n=31) in 1992, presumably in response to coyotes becoming more common. 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 considered superior to small sites (Brian Winter, The Nature Conservancy, personal communication).

The winter ecology of prairie chickens was poorly understood until the study by Rosenquist (1996). He documented the winter use of CRP lands (which accounted for a third of all winter locations) and recommended a rotational disturbance regime and the planting of "hardy" forbs to improve cover values. Recent CRP signups have generally incorporated more diversity in planting mixtures which provides an opportunity to compare winter prairie chicken use of different planting mixtures.

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, lowlands, cropland, and grasslands.

There is recurring interest in reintroducing prairie chickens elsewhere in Minnesota; however, reintroduction sites require relatively large acreages of open grassland and the process is labor and cost intensive. In general, 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. There is, however, substantial grassland habitat available in Big Stone, Lac Qui Parle, and Yellow Medicine counties in western Minnesota, including the Big Stone National Wildlife Refuge and the Lac Qui Parle Wildlife Management Area. With this habitat base, improved knowledge of translocation techniques, and with substantial legislative funding appearing likely, the chances of a successful reintroduction in this area appear good and a project is planned to commence in 1999.

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.* (MNDNR 1990)

The research of Toepfer and his students (Beringer and Rosenquist) generally supports the above plan but studies of the winter ecology of prairie chickens by Rosenquist (1996) provided quantitative data on the importance of private land and associated land uses (agricultural activity and CRP) within the complex of public grasslands. He found survival was reduced when deep snow necessitated winter movements to search for food resources and recommended that food be planted close to adequate roosting habitat. Even in winter, Rosenquist found booming grounds to be important focal points around which to orient management practices for year-round needs.

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 involving prescribed burning, rotational grazing, brush control through summer clearcutting, girdling, and possibly herbicides, is needed to maintain high quality grassland habitat for prairie chickens and their associates. Predation should be reduced with the following practices: 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; a biological indicator of prairies that are healthy for chickens as well as people.

Acknowledgments

We wish to pay a special tribute to field personnel of the Minnesota Department of Natural Resources, U.S. Fish and Wildlife Service, and The Nature Conservancy for their tireless efforts in acquiring and managing grasslands within the prairie chicken range. Without their dedication, prairie chickens would probably be near extirpation in the state and the wealth of prairie plants and animals now enjoyed by Minnesotans would be scarce indeed. Special recognition to the Northwest Experiment Station, University of Minnesota, Crookston for support of the senior author in prairie chicken research and promotional activities. Larry Hanson and Rick Julian (USFWS), Brian Winter (TNC), and Rob Naplin, Earl Johnson, Doug Hedtke, and Doug Wells (MNDNR) provided land acquisition and management data for their respective organizations and/or reviewed a draft of this paper. Appreciation is expressed to the late Robert E. Farmes, Gerald H. Maertens, and William E. Berg of the MNDNR for their review of this paper and to the many members of the Minnesota Prairie Chicken Society for responding to the needs of the chicken.

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History, Status, and Management of the Greater Prairie Chicken in Wisconsin

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This treatise on the greater prairie chicken (*Tympanuchus cupido pinnatus*) was originally written at the request of Dr. F. N. Hamerstrom, Jr., who was approached in the late 1980s to do the same for an anticipated book which was later cancelled. The first version of this paper was completed in 1991, revised in 1993, and again in 1999 for this publication, except the section treating management of the Buena Vista, Paul Olson, and Leola Areas covered by J. Keir, Wisconsin Department of Natural Resources (WDNR) manager of those areas.

Professor Fred Hamerstrom (RKA's graduate supervisor) died in 1990. Dr. Frances Hamerstrom, the second member of that inseparable prairie chicken research team, died in September 1998. This paper is dedicated to them.

Historical Review

The greater prairie chicken, one of 4 species of grouse native to Wisconsin, was common throughout the original tallgrass prairie regions of southern Wisconsin in pre-settlement times. The sharp-tailed grouse (*Tympanuchus phasianellus*) shared some of the chicken range although it was associated with the brushy, oak-savanna ecotone between prairie and deciduous forest. The ruffed grouse (*Bonasa umbellus*) resided in the deciduous forest edge, and northward to the boreal forest, home of the spruce grouse (*Dendragopus canadensis*). These 4 species are still present in Wisconsin today although all but the ruffed grouse exist as small populations.

Schorger (1944) outlined the probable original breeding range of the prairie chicken based on historical accounts from newspapers, popular publications, and scientific literature (Fig. 1). Hamerstrom et al. (1957), refined Schorger's map on the basis of pre-settlement vegetation (Finley 1951, Fig. 2).

Schorger (1944) also cites numerous accounts of the chicken being "very numerous" or "superabundant" as early as 1821 and continuing to be so in many localities until about 1875. Haraszthy, traveling from Madison to Lake Winnebago in 1840, reported ". . .thousands upon thousands of prairie chicken, partridges, and pheasants flew up before us continuously. . . ." (Schorger 1944:312). Other accounts, reported by Schorger (1944:324–326) in-

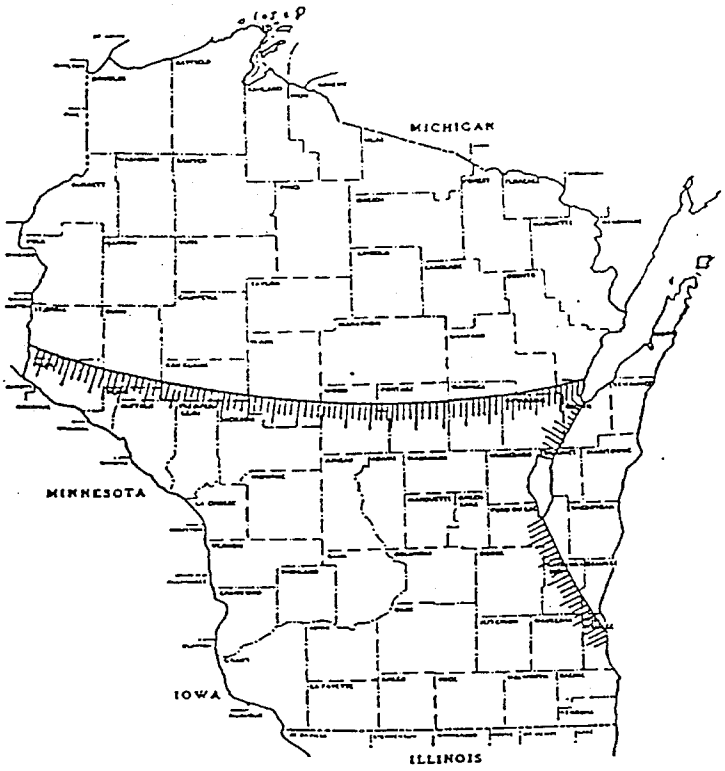

Figure 1. Probable original breeding range of the prairie chicken in Wisconsin (Schorger 1944).

Figure 2. Original range of the prairie chicken in Wisconsin (Hamerstrom, et al. 1957; adapted from Schorger 1944, Finley 1951, and Curtis 1950).

clude: "1884 – 2 men shoot 100 prairie chickens near Milwaukee; 1849 – the average bag for 2 men and a dog was 60-80 chickens; 1854 near Madison – man shot 43 prairie chickens in a few hours, 2 men bagged 128 chickens in 1 day, 1 man shot 143 chickens during a 2-day hunt." Prairie chickens were "common fare" in the Milwaukee markets during this time, selling at $0.25/pair in 1842. Farmers commonly supplemented their income by shooting or trapping prairie chickens. Between April 1847 and April 1848, a market hunter sold 2,420 prairie chickens in Chicago. Railroad lines connected Milwaukee, Madison, Beloit, and Chicago between 1853 and 1864, thus providing an expanded market for prairie chickens and other game. In 1853, a farmer from the Beaver Dam area brought to Milwaukee "...100 dozen quails, 200 prairie chickens, and 100 partridges that had been shot and snared by his son."

Prairie chicken numbers and distribution increased with the spread of agriculture into the original prairie region but it was a relatively short-lived phenomenon. Significant portions of the original range had been converted to agriculture by 1875 and the grassland habitat essential to survival of the bird gave way to cow and plow. Leopold (1931:167) referred to a decline in chicken populations in its original range beginning about 1885. At this same time however, new range was being created in northern Wisconsin coincident with hardwood logging. The chicken expanded its range into the new habitat created by lumbering, subsequent fires, and agriculture. They were present in northernmost Forest County and were reported to be "plentiful and much hunted in Superior" in 1885 (Schorger 1944:357). In 1896, 25,000 chickens were shipped to market from Spooner in northwest Wisconsin (Leopold 1949). Chickens were present in every northern Wisconsin county by 1920. The statewide population of chicken in the late 1800s probably never equaled that of the original prairie range in the south but it was at the zenith of its distribution.

The open grassland habitat in northern Wisconsin began to disappear quickly with the advent of efficient fire detection and suppression in 1927, the abandonment of farms on the rocky soils and rolling terrain, and forest regeneration through natural plant succession and planted conifers. Habitat within the original range to the south continued to be lost to clean farming. The prairie chicken population in Wisconsin declined from both ends of the successional continuum in direct proportion to the loss of grasslands.

A. Leopold and F.J.W. Schmidt, in the first serious attempt to inventory the prairie chicken population in Wisconsin, estimated Wisconsin's prairie chicken population to be 54,850 in 1929 (Gross 1930:26–27). However, Leopold (1931:170–171) believed that figure to be "... a little optimistic. I doubt whether there are that many." By 1950, the chicken had essentially disappeared from its original range in southern Wisconsin. It was common only in central Wisconsin with scattered populations surrounding a core area in Portage, Wood, Waushara, and Adams counties (Fig. 3).

In the early 1900s, far-sighted individuals in Wisconsin became concerned about the

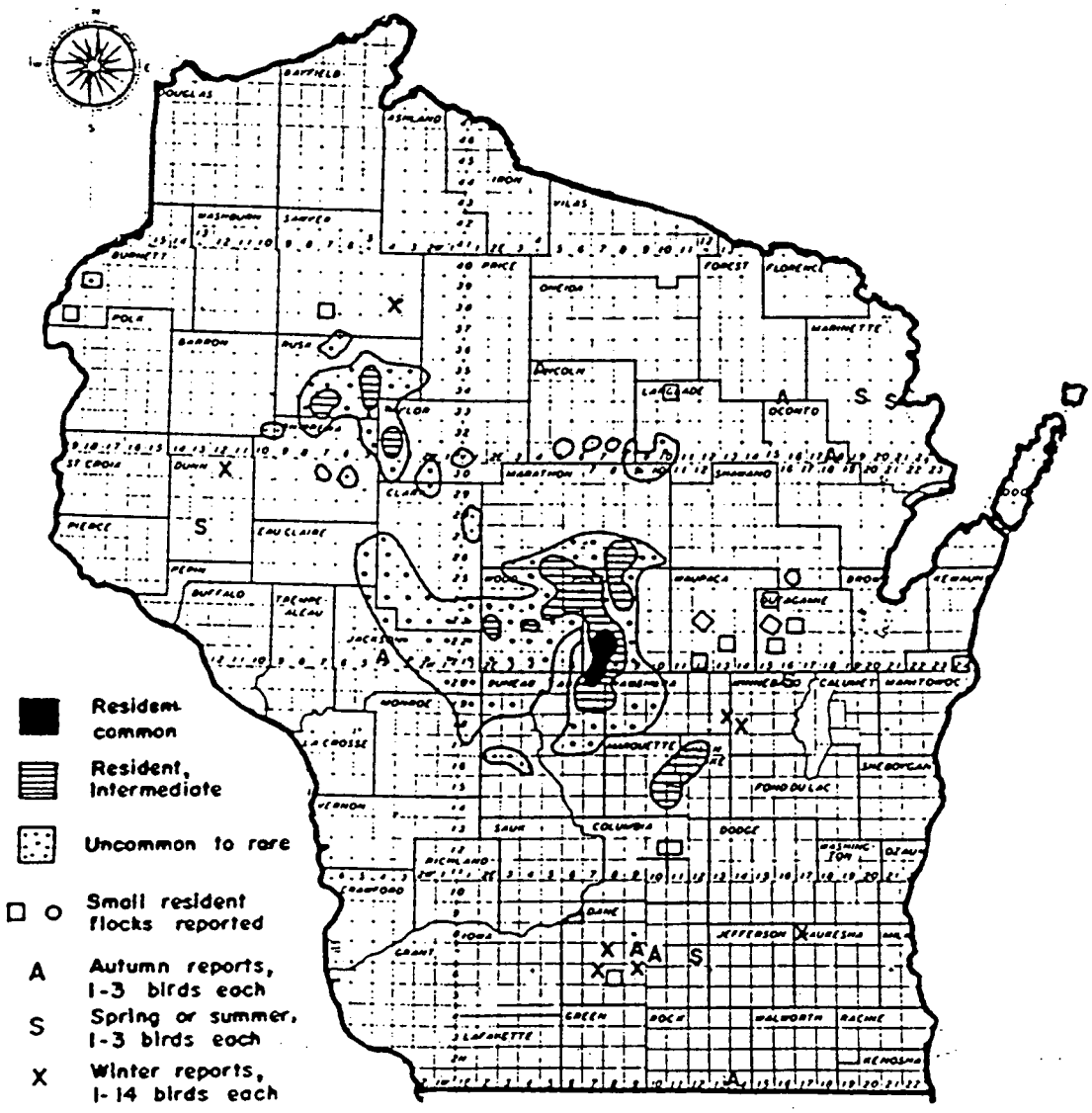

Figure 3. Distribution of the prairie chicken in Wisconsin, 1948–53 (Hamerstrom et al. 1957)

chicken's future and initiated early management and research efforts. The first management was the Van Wormer-Jones Program in 1928 which established buckwheat food patches and grain shocks for prairie grouse winter food in the Babcock area of central Wisconsin for 5 consecutive years (Grange 1948). The first research began when M.L. Jones, chief of the Wisconsin Conservation Department (now Wisconsin Department of Natural Resources) Research Bureau, commissioned A. O. Gross of Bowdoin College in Maine, to conduct a study of Wisconsin prairie chickens in 1929 and 1930. Gross had considerable experience with the heath hen (*T. c. cupido*) of the northeastern United States. He set the stage for management and studies of the prairie chicken in Wisconsin by recommending "restoration of the marshlands," "the acquisition of land for refuges and winter feeding stations," and stricter hunting regulations (Gross, 1930).

F.J. Schmidt, an assistant to Gross, continued Wisconsin prairie chicken studies under A. Leopold from 1931 to 1935 at which time he died in a house fire that also consumed most of his research data.

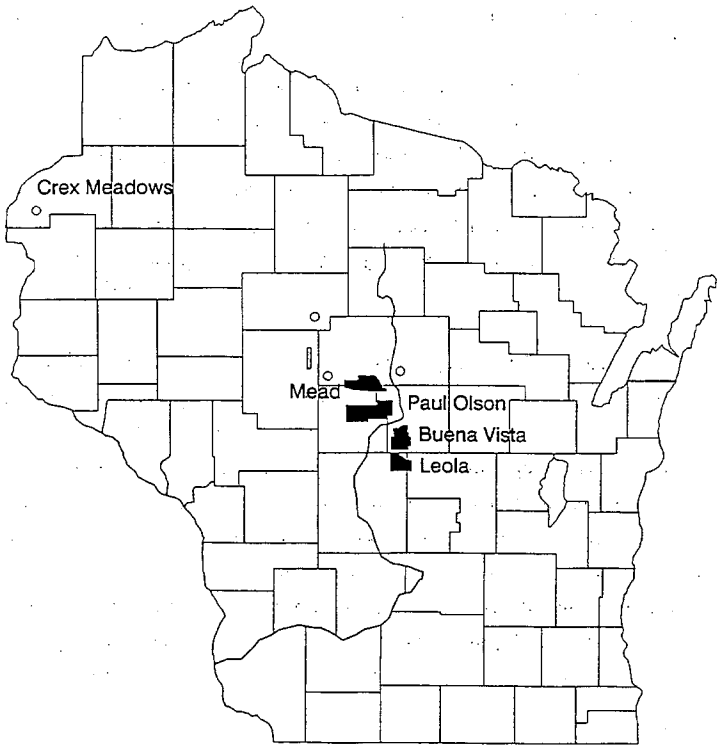

Figure 4. Location of prairie chicken management units and outlying populations in Wisconsin, 1990.

Frederick and Frances Hamerstrom began their prairie chicken research in central Wisconsin under A. Leopold in 1935. They continued this research under various auspices, with a 3-year break in continuity from 1944 through 1946, until 1971 (Hamerstrom and Truax 1938; Hamerstrom 1939, 1940; Hamerstrom and Morgan 1941; Hamerstrom et al. 1941). Their most intensive prairie chicken ecology studies were focused on the Buena Vista Marsh and the Plainfield Area (now called the Leola Area) between 1948 and 1971 (Hamerstrom and Hamerstrom 1949; Hamerstrom 1950, Hamerstrom and Hamerstrom 1955; Hamerstrom et al. 1957; Hamerstrom and Hamerstrom 1960, 1961; Berger and Hamerstrom 1962; Hamerstrom and Hamerstrom 1963; Berger et al. 1963; Hamerstrom and Hamerstrom 1964; Hamerstrom and Mattson 1964; Hamerstrom et al. 1965; Hamerstrom and Hamerstrom 1966, 1967; Anderson and Hamerstrom 1967; Hamerstrom and Hamerstrom 1968; Anderson 1969a, 1969b; Westemeier 1969, 1971; Hamerstrom and Hamerstrom 1970, 1973; Hamerstrom 1977).

By 1950, prairie chickens were common residents in only 4 areas in central Wisconsin, the Leola Area in Adams and Waushara counties, the Buena Vista Marsh in southwestern Portage County, the Paul Olson Prairie Chicken Management Area in west-central Portage and east-central Wood counties, and the Mead Wildlife Management Area in south-central Marathon County (Fig. 4). There were a few scattered, intermediate or low density populations in some outlying areas immediately adjacent to these units.

Hamerstroms identified the Buena Vista Marsh as being the logical area to concentrate prairie chicken management efforts because of the existing habitat, the lack of conflicting land uses, and the low land values. The Buena Vista Area is a 50,000-acre (20,250 ha) pseudo-prairie composed mainly of introduced grasses and native forbs. It was originally a tamarack (*Larix laricina*) swamp in the

lakebed of Glacial Lake Wisconsin with extensive portions of open marsh and speckled alder (*Alnus rugosa*) shrubs (Zedler, 1966). The tamaracks gave way to sedge meadows (*Carex* spp.) by the late 1800s following frequent and intensive burning of the marsh during drought years. This fostered large stands of marsh grass dominated by bluejoint (*Calamagrostis canadensis*). Prairie chickens were numerous in this wet grassland with wide horizons. A drainage district was formed and, beginning in 1903, the marsh was drained for agriculture by a series of ditches. Farming generally failed because of a short growing season, defective drainage, and the acid peat soils that were deficient in potash and phosphorous (Westemeier 1971). Many farms were abandoned and the drainage district became inactive but was not dissolved.

The prairie chicken population increased to a peak during and shortly after the drainage. Leopold (1931) estimated the prairie chicken population in Portage County to be 4,000 birds in 1930. Hamerstroms (1955) reported the Leola Area population to be relatively stationary at 260 and 238 booming cocks in 1940 and 1950, respectively. Westemeier (1971), extrapolating from the Hamerstrom data, estimated the Buena Vista population to be 600 booming cocks between 1940 and 1950; Hamerstroms (1973) determined it to be 550 cocks in 1950.

A bluegrass (*Poa* sp.) seed industry gradually replaced the dairy and grain farming on the Buena Vista, starting in the 1920s and continuing into the early 1960s when it failed because of foreign competition. Bluegrass farming was compatible with prairie chickens because of the timing of associated rotational burning, mowing, and grazing practices that maintained the bluegrass, and the method of seed harvest that stripped only the seedheads, leaving the stems and leaves for cover.

The approximate boundaries of the now inactive drainage district became the prairie chicken management area on the Buena Vista Marsh and Hamerstroms and Mattson designed an ecological scatter-pattern management plan for the area (Hamerstrom et al. 1957). The plan called for the acquisition of key, small (40–80 acres [16.2–32.4 ha]) parcels of land scattered strategically throughout the entire area (Fig. 5). This pattern incorporated existing land-use practices of bluegrass and dairy farming, and cattle ranching, both of which were compatible with prairie chicken needs for wide horizons and permanent grasslands. The Wisconsin Conservation Commission, in keeping with its historic commitment to the preservation of prairie grouse, adopted a *Prairie Grouse Management Policy* in 1953 which called for restoration and management of habitat.

A program to purchase a scatter-pattern of grassland reserves was initiated in the early 1950s. The first parcel (63 acres [26 ha]) was purchased in 1954 by Mr. and Mrs. Gordon E. Kummer. In 1955, The Wisconsin Society of Ornithology and Mr. and Mrs. Clarence Jung each purchased 40 acres (16 ha). These beginnings were enormously important but the pace had somehow to be stepped up. In 1958, Paul Olson set up the Prairie Chicken Foundation within the Dane County Conservation League and, with the help of William H. Pugh, things began to move. Then in 1960, the Society of Tympanuchus Cupido Pinnatus (STCP) was established by Willis G. Sullivan, Sr., John Best, and Ferdinand Heinrichs and the program of private purchase reached full stride (Hamerstrom and Hamerstrom 1973). The Prairie Chicken Foundation made its first purchase of land in 1959; by 1973, they had purchased 1,641 acres (665 ha). The Society of Tympanuchus Cupido Pinnatus, a startlingly vigorous, Milwaukee-based organization, purchased 1,200 acres (486 ha) in 1961 and ultimately bought 7,000 acres (2,835 ha). By 1973, 10,806 acres (4,376 ha) within the Buena Vista Area had been purchased by private organizations and individuals and leased to the WDNR for prairie chicken management. Land purchase continued on the Buena Vista (total: 11,800 acres [4,779 ha] by 1980, Fig. 6) and was extended to key areas in the Leola Area (900 acres [365 ha]) and the Paul Olson Area (1,790 acres [725 ha]).

The Wisconsin Conservation Commission declared in 1955 that it stood ready to lease and manage suitable lands which were privately purchased for prairie grouse. The nomi-

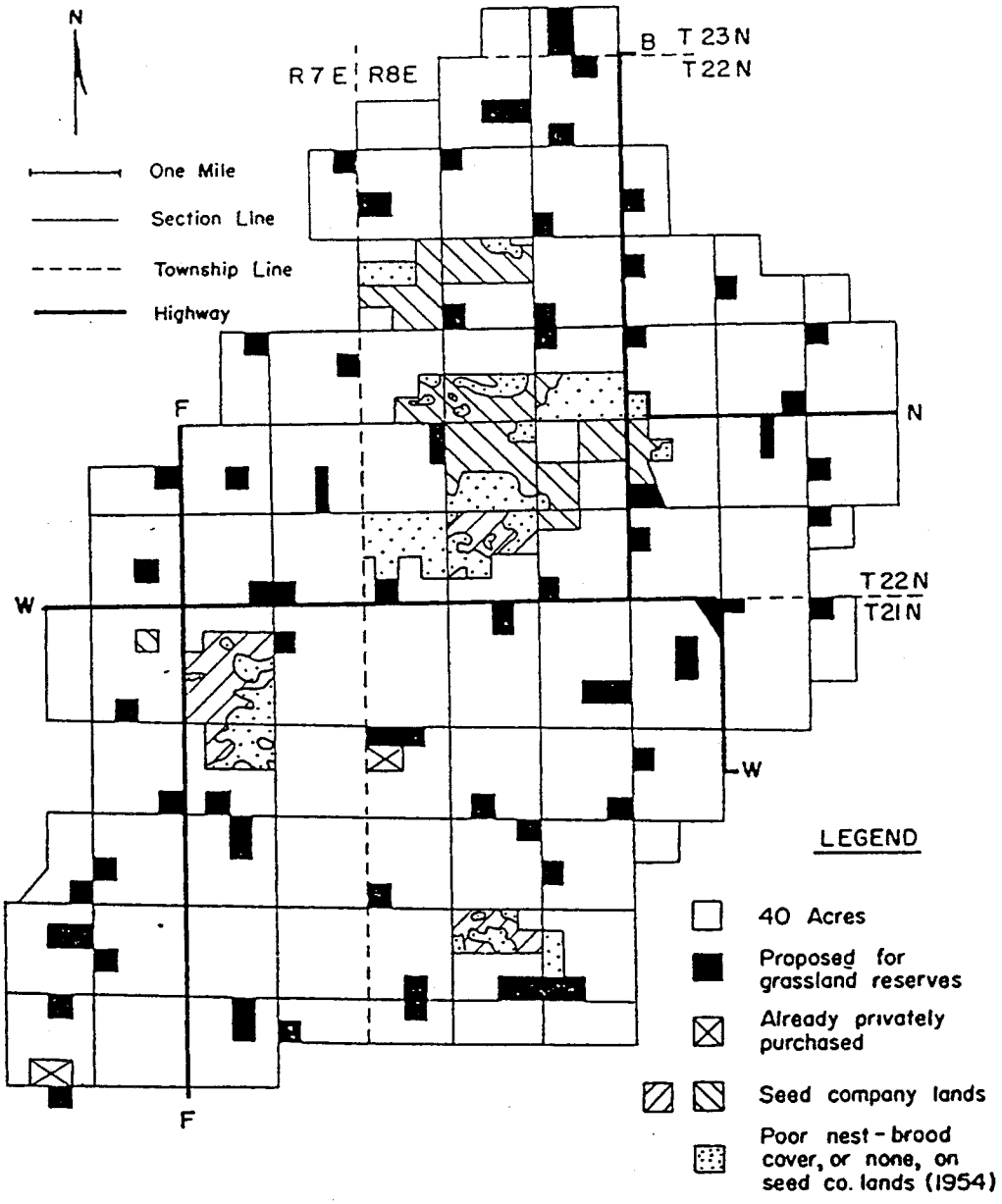

Figure 5. Scatter-pattern of grassland reserves for the Buena Vista Marsh Management Area needed to ensure the continuity of breeding units throughout the Area (Hamerstrom et al. 1957)

nal lease money was equivalent to the amount of the local taxes which were then paid to local governments. The WDNR would manage these long-term (99 years), leased lands for prairie chickens. The leases were to remain in effect as long as the lands were managed for prairie chickens.

The WDNR commenced managing the acquired lands upon acquisition and lease. Initial management efforts, designed and implemented by Mattson, consisted of practices that would restore lands that had been invaded by trees and shrubs through natural succession to permanent grasses, establishing winter food patches, and maintaining existing grasslands by mowing, burning, controlled grazing and using herbicides. Aspen (*Populus tremuloides*) was the principal tree invader, and spirea (*Spirea tomentosa, S. alba*), and willow (*Salix* spp.), the chief shrubs. Mature aspen stands were costly to convert and

hence land purchases with large stands of these species were avoided or, except for key parcels, not converted to grasslands.

J. Berkahn, WDNR wildlife manager who succeeded Mattson in 1966, designed a management plan for the Buena Vista that divided the 11,800-acre (4,779 ha) reserve lands into 40 units (Fig. 7). Each unit was further divided into 20-acre (8 ha) strip-parcels to facilitate treatment on a 4 or 5-year rotation. This pattern was followed and slightly modified by B. Gruthoff, Berkahn's successor, between 1973 and 1982 during which time he incorporated results of research conducted by Toepfer and Tesky (Toepfer 1988) and Halvorsen (Halvorsen and Anderson 1983) into the management program. J. Keir assumed management responsibilities in 1982 and continues today as WDNR prairie chicken manager on the Buena Vista, Leola, and Paul Olson Areas.

The chicken population on the Buena Vista declined 50% in the mid-1950s (Table 1, Fig. 8) coincident with the downside of the 10-year cycle of other grouse species in the Lake States (Keith 1963). It continued to decline an additional 46% and stabilized at a mean of 151 cocks (range = 104–183) throughout the 1960s as other grouse populations rose and fell on schedule with the cycle (Thompson and Moulton 1981). The chicken population increased to 234 cocks by the next cyclic peak in 1972, presumably in response to the land acquisition program and subsequent management. The subsequent cyclic trough in the mid-1970s was slightly higher than the preceding one and the following peak of 550 cocks in 1981 equaled the high point of 1950–51. In 1951, booming grounds were distributed over a 100 square mile (256 km^2) area. In 1981, the chicken population density doubled with that same number of cocks occupying booming grounds within a 50 square mile (128 km^2) area. (*Here, we refer to the communal breeding area of the prairie chicken as a booming ground in keeping with it being uniquely descriptive for that bird [Toepfer 1991]*). The population declined since 1981 to a mean of 231 (range = 182–281) cocks between 1984 and 1991. The expected rebound at the beginning of this decade did not materialize but the population in the subsequent trough of the mid-1980s was 86% higher than the lowest recorded population of 104 booming cocks in 1969, precariously close to the minimum level of 100 booming cocks for a healthy population (Toepfer 1988).

Row-crop farming with center-pivot irrigation was initiated on private lands on the Buena Vista Marsh in the 1960s. Principal crops were potatoes, snap beans, peas, and sweet corn. This agricultural venture was immediately successful because of the huge aquifer that underlies the area, the availability of chemical fertilizers, new agricultural chemical technolo-

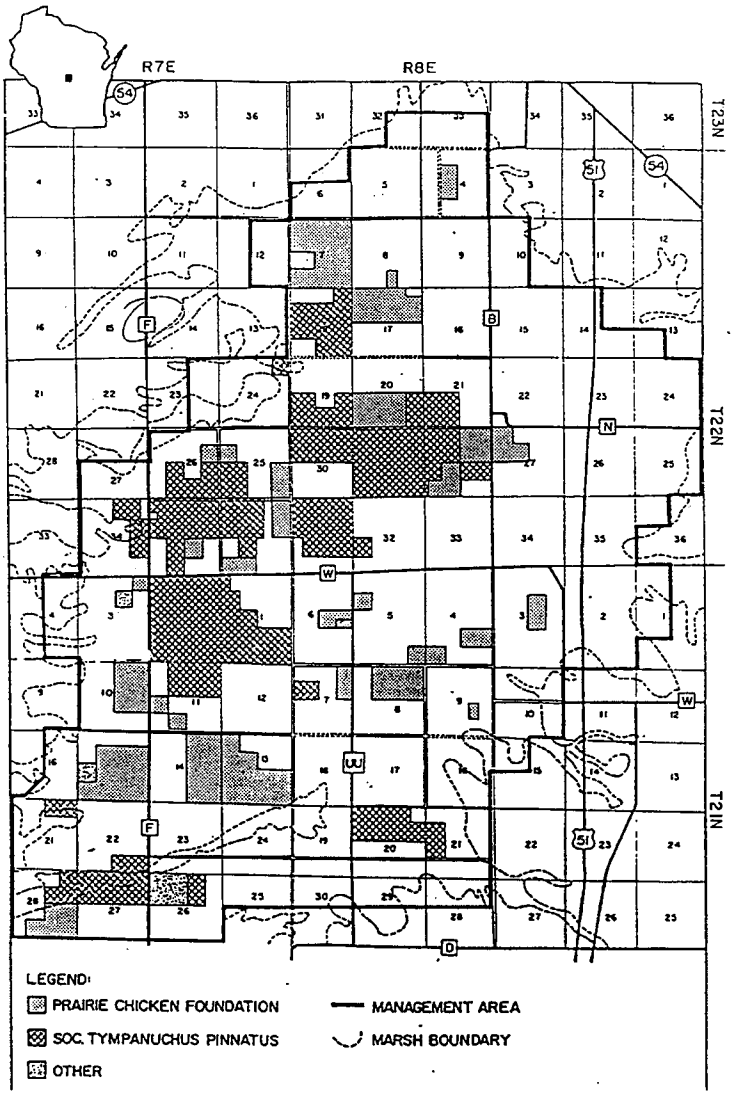

Figure 6. Land privately purchased for prairie chickens on the Buena Vista Marsh, Portage County, through 1971 (Hamerstrom and Hamerstrom 1973)

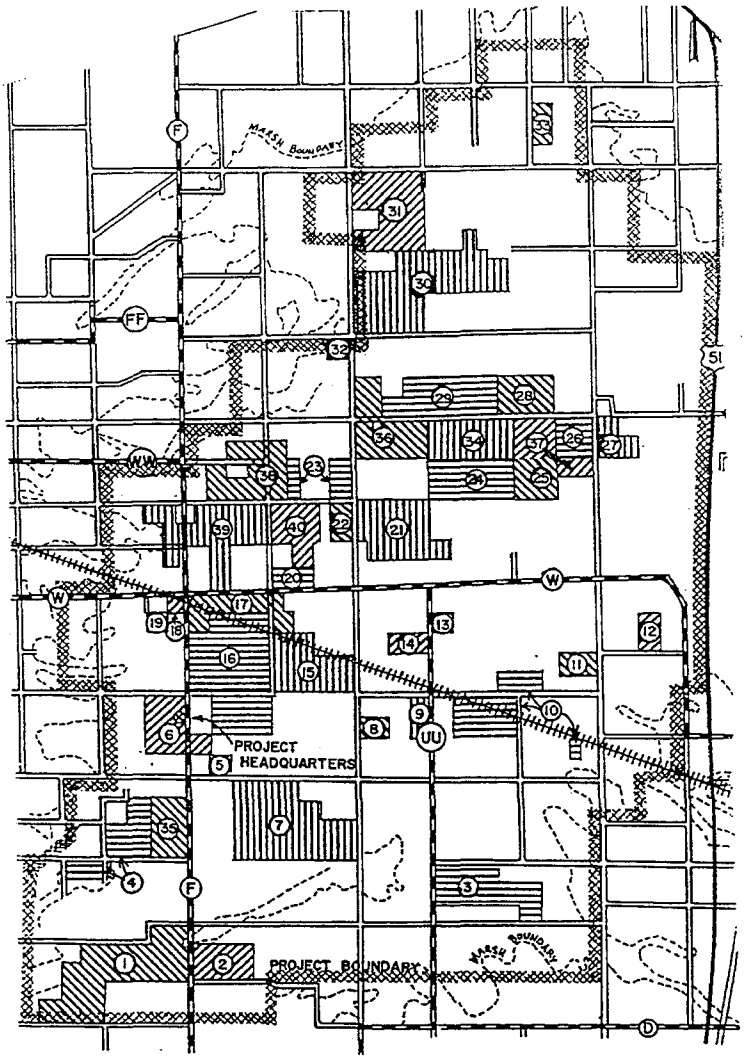

Figure 7. Buena Vista Marsh grassland reserve management units designed by J. Berkahn (WDNR).

gy, and the advent of short-season row crops. The drainage district was reactivated and the original ditches were re-dredged. Hundreds of acres of permanently sodded lands associated with dairy farms and cattle ranches were converted to irrigation farming.

By 1968, 680 acres (275 ha) of private grasslands had been converted to irrigation farming (Hamerstrom and Hamerstrom 1973). At least 11,000 acres (4,455 ha) were in irrigated row crops in 1998. In addition to the loss of habitat, the concomitant use of aerially applied pesticides associated with irrigation farming, poses an additional potential threat to prairie chickens and other wildlife on the management area.

Land values increased dramatically with the advent of irrigation farming and local taxes increased proportionately. Management lands were originally purchased for $17.50 per acre in the late 1950s and early 1960s, and taxes were $1.00 per acre. Better land is now selling for up to $2,500 per acre (Portage County, UW-Extension, personal communication) and taxes and associated lease costs to WDNR have increased proportionately. The total lease cost in 1989 was approximately $100,000. Another $3–$4,000 was paid annually for assessments by the drainage district. At that time, the WDNR offered to purchase the lands from private owners. A major landowner, STCP, agreed to sell their 7,000 acres (2,835 ha) to the state of Wisconsin for $1 million, approximately half of the appraised value, with the stipulation that the lands continue to be managed for prairie chickens. Sales of other private lands are being negotiated at the present time.

The amount of prairie chicken habitat within the Leola Area fluctuated dramatically between 1941 and 1969 because 3 landowners controlled 47%, 32%, 51% and 18% of the area in 1941–42, 1947, 1956–57 and 1969, respectively (Hamerstrom and Hamerstrom 1973). Land-use practices changed several times since 1969. At times, the land was fallow and supported grassland wildlife. Cattle ranching and other forms of agriculture negatively modified the grasslands at other times. The chicken population mirrored these changes (Fig. 8, Table 1).

The status of prairie chicken habitat on the entire Paul Olson Area is unknown today although a portion of it was inventoried in 1991–92 (WDNR 1993). The population here increased significantly from 54 booming cocks at the first census in 1962 when small farms failed and 1,700 acres (688.5 ha) were acquired for chicken management. It has fluctuated in a pattern generally similar to that of the Buena Vista since then; from a high of 302 cocks in 1981 to lows of 56 in 1992, and 129 in 1998. The recent partial inventory of this area reported prairie chicken nesting

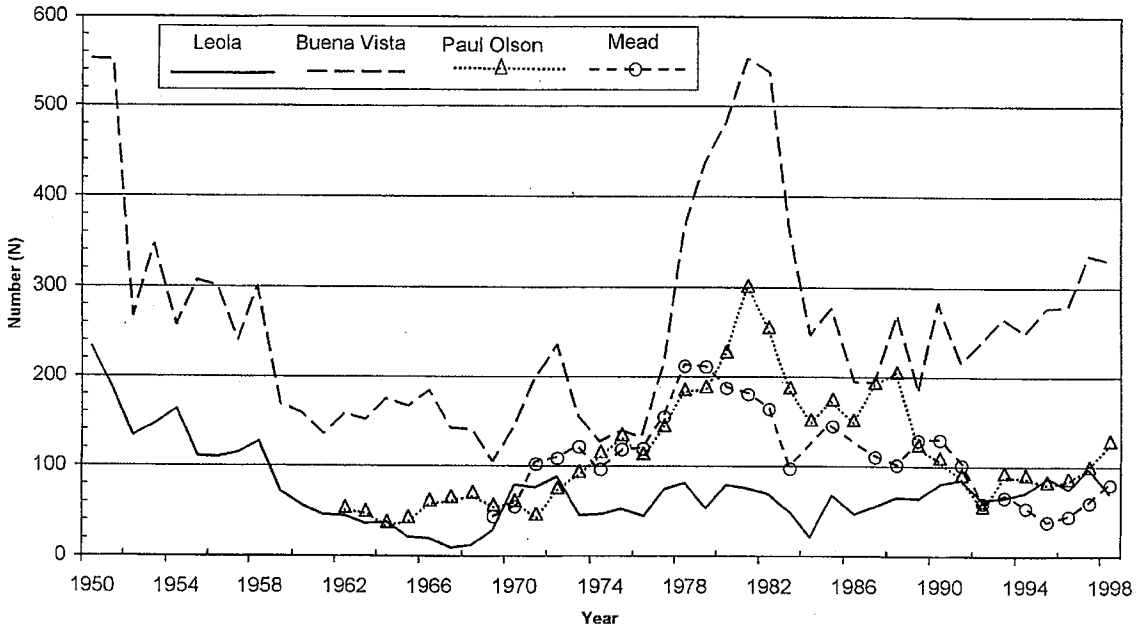

Figure 8. Prairie chicken cocks on central Wisconsin booming grounds.

cover having increased from 22% to 24% between 1962 and 1991 but that "woods, brush, and miscellaneous" also increased 23% to 40% of the area during the same time. Dairy and grain farming is still a significant activity on the heavy soils of this area. Although 1,700 acres (689 ha) were purchased and are being managed for prairie chickens, there are indications that recently intensified grain farming on private land and the increase in "space-destroying" trees and shrubs, may be influencing chicken populations.

The Mead Wildlife Area is publicly owned with about two-thirds of the 27,000 acres (10,935 ha) being managed principally for waterfowl; the remainder is forested. Prairie chickens benefit from the wide horizons and the maintenance of grass-forb communities adjacent to managed impoundments, the sharecropping programs, and nearby private agricultural lands. A significant portion of the chicken population in this area resides on the dairy and grain farming areas adjacent to, and south of the Mead Wildlife Area. The soils and farming practices are similar to those of the Paul Olson Area, approximately 15 miles (24 km) farther south with a band of forested land between them.

There is considerable interchange of prairie chickens between the 4 major areas. Hamerstroms (1973) documented 13 instances of chickens, leg-banded on the Buena Vista, being recovered in the Paul Olson Area (10) or Mead Wildlife Area (3) between 1950 and 1969. Telemetry studies also revealed interchange between the Buena Vista and Leola areas during the winter months (Toepfer 1988) and current studies by Toepfer have documented several additional interchanges.

Prairie chickens existed in the Crex Meadows area of northwest Wisconsin and in Douglas County, until 1947. Original prairie habitat in that area was gradually invaded by oak (*Quercus* spp.) forest with the cessation of fires. A vigorous habitat management program, using prescribed burning under the direction of Norman Stone, then WDNR Wildlife Manager at Crex Meadows Wildlife Area, restored much of the native prairie community. Pen-reared and wild prairie chickens were reintroduced there in 1974–78 and monitored by Toepfer (1988). Habitat deterioration was again largely responsible for a second decline in chicken abundance. Two cocks were present in 1990, 3 in 1991, none thereafter.

Table 1. Number of prairie chicken cocks on booming grounds in central Wisconsin by census unit.

Year	Buena Vista [a]	Leola	Paul Olson	Mead	McMillan	Outlying	Total
1950	550	232	[b]				
1951	550	183					
1952	265	132					
1953	344	146					
1954	256	162					
1955	305	110					
1956	299	109					
1957	239	114					
1958	297	126					
1959	169	72					
1960	157	56					
1961	135	46					
1962	157	44	54				
1963	150	37	50				
1964	175	38	38				
1965	165	21	43				
1966	183	20	62				
1967	141	10	66				
1968	139	12	71				
1969	104	28	57	43			
1970	141	78	62	54			
1971	198	77	47	102			
1972	234	88	76	108			
1973	155	46	94	121			
1974	126	46	116	96			
1975	138	52	135	118			
1976	131	45	114	119			
1977	213	75	145	154			
1978	365	82	186	212			
1979	438	53	189	211			
1980	480	79	228	187			
1981	550	75	302	180	14		1121
1982	535	69	256	163	13		1036
1983	359	49	188	97	4		697
1984	245	22	152				
1985	275	68	175	144	7		670
1986	194	47	152				
1987	193	56	194	110	25		578
1988	269	65	206	101	31		672
1989	182	64	124	128	37	56	591
1990	281	80	110	129	60	49	709
1991	216	84	91	101	64	70	626
1992	239	63	56	58	30	60	506
1993	265	65	93	65	24	45	557
1994	247	70	91	53	19	30	510
1995	275	87	83	38	24	31	538
1996	277	74	87	44	20	39	541
1997	334	97	100	59	9	22	621
1998	327	70	129	79	14	30	649

[a] Names of census units, "Outlying" = combined adjacent outlying areas.

[b] Blank spaces = census not conducted; prairie chickens may have been present.

Low numbers of prairie chickens are present immediately adjacent to the 4 central Wisconsin management areas (Fig. 4). A few small outlying populations still exist to the west and northwest of the Mead Wildlife Area. One of these populations resides immediately adjacent to another state-owned wetland management area, the McMillan Marsh. This area has been censused by WDNR personnel since 1981. The remaining outlying populations are along the Marathon-Clark-Taylor county lines from Marshfield to Medford. Chickens have probably existed in this area since at least the 1950s. There were 60 and 45 booming cocks on 14 booming grounds in these outlying areas in 1992 and 1993, respectively. WDNR (1993) reported that approximately 65% of this area was in some form of agricultural use and that 26% was potential prairie chicken nesting cover. The composition and extent of prairie chicken habitat, and the dynamics of the populations in these areas, have not been determined.

Census Procedures

Hamerstroms censused Buena Vista and Leola areas from 1950 to 1971. Censuses of the Buena Vista since 1971 and the Paul Olson Area since 1963, were conducted by personnel from the University of Wisconsin-Stevens Point. R. K. Anderson censused the Paul Olson area from 1963 through 1993 and the Buena Vista from 1971 through 1993. L. Nauman and E. Merrill continued the censuses on the Buena Vista and the Paul Olson areas from 1994 through 1998 with substantial participation by J. Toepfer in 1997 and 1998.

We closely followed the procedures outlined by Hamerstrom and Hamerstrom (1973) to maintain census continuity and integrity for these 2 areas with significant historical data. This involved finding all booming grounds and counting all cocks on each ground. The peak of mating activity occurs on 21 April, plus or minus 3 days in central Wisconsin. Each area is searched twice between the last week in March and 30 April. Searches are conducted for 1.5 to 2.0 hours beginning about 45 minutes before sunrise, by listening for booming cocks which can be heard with optimum weather conditions (clear skies, temperatures at 25–40°F, and no wind) for at least 2 miles (3.2 km). Booming ground locations are determined by triangulating booming calls from known positions and by sight. Winds influence the direction and distances from which booming can be heard and thus dictate listening point intervals. All cocks on each booming ground are counted at least 3 times during the peak display period in the spring. Booming grounds that are completely visible are counted with spotting scopes and binoculars. These counts are verified by flush counts when hens are not present as indicated by the absence of whooping and flutter-jumping by the cocks. Others are counted by observers in blinds on the edges of the booming grounds.

The Mead, McMillan, and Leola areas are censused by WDNR personnel. Censuses in these areas are not as intensive as those on the Buena Vista and Paul Olson areas but are consistent between years and basically follow Hamerstroms' procedure with variations imposed by time and budget constraints. Outlying areas are censused by volunteer individuals and local birding organizations with variable intensity.

Harvest and Hunting Pressure

The prairie chicken program that began in 1928 in Wisconsin ". . .was originally pointed toward the management of huntable populations" (Hamerstrom and Hamerstrom 1973). At that time, the chicken was an important game bird in the State. The objectives of the program gradually changed to one of preventing extirpation. Although Wisconsin's chicken population still faces threats, the danger of extirpation has been significantly ameliorated. A reasonable goal at this time should be to bring the population to a huntable level. Hamerstrom et al. (1957) discussed the circumstances under which prairie chickens could be hunted in Wisconsin. Those speculations are still valid.

Prairie chickens have not been hunted in Wisconsin since 1955. Hunting seasons were open statewide from 1938 through 1942 when chickens were still present in every county of the state. Seasons were closed in 1942 until 1950 when they were opened in select counties, or parts thereof, until 1956 when they were closed again throughout the state. Chicken populations rose and fell irrespective of hunting during the irregular schedule of open and closed seasons between 1938 and 1955 (Hamerstrom et al. 1957).

A well-regulated hunting season that would not increase the natural mortality rate of the prairie chicken is feasible. However, it would require delisting the prairie chicken from its current *threatened* status in Wisconsin and legislation that would permit regulation of hunter density in designated areas within appropriate diurnal and seasonal time frames. Control of hunter density is now authorized only for turkey (*Meleagris gallopavo*) and black bears (*Ursus americanus*), and for research purposes within the Sandhill Wildlife Management Demonstration Area.

Public opposition to a prairie chicken hunting season can be expected from some of those who watch the booming of chickens from blinds each year for recreation and those who contributed money to "save the prairie chicken" from impending extirpation in the past. This presents a challenge and opportunity to design a quality hunt that would be compatible with the population dynamics of the chicken, would not demean the resource, and would be socially acceptable. Such a hunt could be a model for hunting other species and thus begin to restore the quality and sportsmanship that is steadily disappearing with increased hunter density and the advent of gadgetry.

Potential Harvest

The possibility of a spring hunt of prairie chickens could be considered. Very few species lend themselves to a highly regulated hunt as do prairie chickens. Booming ground locations and numbers of cocks can be determined with a high degree of accuracy. Small grounds could be protected and the trophy harvest of cocks directed to larger grounds when hens are not present as indicated by cock behavior. Allowable harvest could be set and easily monitored for specific booming grounds. This concept could also be applied in the fall of the year when some booming grounds are attended during the autumnal display period or during spring evenings when few hens are present. A hunting season of this nature would be difficult to administer on private lands. The Mead Area would hold the greatest potential for controlled hunting because, of the 4 major areas in central Wisconsin, it has the highest percentage of booming grounds (65%; 14 of 22) on public lands; the Buena Vista has 29% (9 of 31) on public land, and Paul Olson has 6% (1 of 16). Chickens are attracted to the bare soil and grazed or mowed areas adjacent to grasslands for booming and most of these are on private land in the Buena Vista and Paul Olson Areas. The Leola population is too small to be hunted at this time.

The largest negative aspect of a highly controlled hunt of this nature is that it precludes the hunter from participating in the total hunt essentially relegating the experience to one which borders on being only a "shoot." This has happened in hunts of many other species in North America when unlimited hunter densities precludes a complete hunt. It is unfortunate that an increasing number of hunters have not had the opportunity to participate in a complete hunt and thus consider their "shoot" to be a "hunt;" they are not to be blamed for they know not of a hunt. In many instances, wildlife agencies foster a "shoot" through management practices and strategies.

Specific Needs

Circular irrigation farming has converted much (a minimum of 11,000 acres [4,455 ha]) of the permanently sodded private lands within the management boundaries and currently threatens prairie chicken populations on the Buena Vista Area. Hamerstrom et al.'s (1957) original ecological scatter-pattern manage-

ment plan was based upon the premise that private lands (about 75% of the area), adjacent to the lands secured for maintenance of permanent grass-forb habitat, would remain as such and thus provide some of the necessary habitat components, viz wide horizons, brood-rearing habitat, and winter cover. Subsequent conversion of much of this private land to irrigation agriculture has eliminated a significant amount of these habitat types from the landscape. Irrigation has also lowered the water table and thus changed the ecology of the area. Prairie chicken land management strategies may need modification in light of current conditions resulting from these changes in land use since the original plan for the Buena Vista was formulated.

Other areas in Wisconsin that have potential prairie chicken habitat should be evaluated for possible reintroduction programs. This would expand the range of the chicken and provide security that accrues with dispersed populations. Areas of greatest potential in Wisconsin would include large wetland areas that are being managed primarily for waterfowl. Those complexes that are near agricultural lands have the greatest potential for satisfying chicken habitat needs. Prairie chickens and upland nesting ducks are compatible with similar habitat requirements. Undisturbed, upland grasslands are essential for dabbling ducks and prairie chickens and are often a limiting factor for both species. Wetland vegetation, in the form of sedges is prime winter cover for Wisconsin prairie chickens. Winter food can be provided in adjacent agricultural uplands and the space factor is usually present in wetland situations. Areas considered for reintroduction should contain a minimum of 3,500 acres (1,418 ha) of grassland habitat (Toeper et al. 1990).

By the same token, some grasslands that are managed for prairie chickens in Wisconsin, with water tables near the surface, could be modified to create conditions for dabbling ducks by providing breeding and brood-rearing waters that would have little negative impact on chicken habitat. This would increase the biodiversity of these areas by creating habitat for other species associated with grass-wetland complexes.

Public Needs

Watching the courtship display of the prairie chicken is very popular in Wisconsin. The booming of prairie chickens, like the cry of loons, howl of wolves, bugle of elk, and goose music, is a classic wildlife sound. Approximately 900 persons view the mating ritual of chickens each spring through a program at The University of Wisconsin-Stevens Point. Six 4-person blinds and numerous 2-person blinds, strategically placed on the edges of booming grounds, accommodate an average of 28 viewers each day during April. Viewers are briefed on prairie chicken life history, sex determination, behavior, census methods, and blind-sitting deportment prior to being guided to blinds. They are requested, and instructed, on how to record observations on field forms to assist with the annual census of the Buena Vista and Paul Olson areas. Those who are viewing prairie chickens specifically for census purposes, are debriefed after the morning show to clarify their observations. Viewers from Finland, England, Germany, France, Australia, China, Norway, Sweden, South Africa, Canada, and most of the United States have been hosted during the past 15 years. Many universities, colleges, and high schools from Wisconsin and adjacent states have also availed themselves to this viewing opportunity as a learning experience for related classes each spring. A modest fee of $5.00 per adult and $3.00 per student helps defray the cost of guide transportation and salaries, blind dispersal, retrieval, and maintenance, briefing, and scheduling.

There is a greater need for education about the value of prairie chicken habitat to all organisms associated with grassland ecosystems. Undisturbed grassland habitat, because of its value for agriculture and rangeland, is now one of the rarest habitat types in this hemisphere. It is becoming scarcer as greater demands are placed upon it for human use.

The value of permanent, undisturbed grasslands as wildlife habitat, natural ecosystems, outdoor laboratories, and demonstration areas to educational institutions and the general public, needs recognition and promotion.

Management

BUENA VISTA, PAUL OLSON WILDLIFE AREA, LEOLA

(originally submitted in 1990 by J. Keir, WDNR manager of these areas. For an update, see Keir 1999).

Approximately 13,000 acres (5,265 ha) are managed specifically for prairie chickens on these areas; mostly on Buena Vista. Current techniques include burning, mowing, grazing, herbicide use, and sharecrop farming. The management goal is to create the maximum amount of undisturbed nesting cover.

Burning is conducted on a 5-year rotation, in early spring, after snowmelt. Approximately 1,000 acres (405 ha) are burned each year with a typical size of burned parcel being 80 acres (32 ha). Fire at this time of the year removes residual herbaceous vegetation and the duff layer but has limited or no effect on controlling encroachment of woody species. There are some indications that the limited mid-summer burns on the heavy soils of the Paul Olson Area do control woody vegetation. Summer burns on the organic soils of the Buena Vista and Leola units are not feasible because of the likelihood of peat fires.

Controlled grazing has effectively controlled woody vegetation on the Buena Vista (Fasbender 1987). Woody vegetation within a prescribed grazing unit is mowed during the dormant season; it is then grazed during the following growing season between mid-May and late September. Cattle browse, and thus control, the growth of new shoots of woody vegetation. Heavy stocking of about 0.3 to 0.4 animal units per acre is currently encouraged. Approximately 500 acres (203 ha) are grazed each year on 120-acre (49 ha) units with a 6-year rotation on the Buena Vista Area.

A corn-oats-hay farming rotation of 20-acre (8.1 ha) parcels is conducted annually within 12, 160-acre (65 ha) units on the Buena Vista Area on a 16-year rotation. Corn is planted on and hay is cut (between 15 July and 1 August) annually from 20-acre (8 ha) parcels within each unit. The specific use of each 20-acre (8 ha) parcel consists of corn in years 1 and 2, oats over grass/legume seeding in year 3, hay in years 4 and 5, and undisturbed grass-legume for the remaining 11 years. Four acres of the 20-acre (8 ha) corn parcels are left standing as winter food patches. The 3 successive years of plowing is expected to preclude the encroachment of woody vegetation on the farmed units. Approximately 500 acres (203 ha) of management lands are farmed annually through this program.

Between 60 and 100 acres (24 and 41 ha) of project lands are treated each year by plowing and disking to fragment large monotypic stands of Canada goldenrod (*Solidago canadensis*) on the Buena Vista. This treatment was experimentally initiated to increase the diversity of herbaceous vegetation and presumably habitat quality.

Broadleaf herbicides were used extensively in the late 1960s and throughout the 1970s, during the early years of prairie chicken management on the Buena Vista. Herbicide use has been greatly reduced in the past few years as non-chemical controls received greater emphasis; chemicals were not used in 1989 and 1990.

MEAD WILDLIFE AREA

(By T. Meier, WDNR manager of this area.)

Approximately 500 to 1,000 acres (203 to 405 ha) are treated annually with spring burns on this area although it varies considerably with weather and flood conditions that influence management of this wetland area. Fall burns are being tested to determine their effect on woody vegetation after an early October 1996 wildfire revealed considerable potential for killing willow and alder.

Brush mowing is undertaken in the wetland sedge meadow habitat during dry summers and winters of thick ice. When these conditions exist, up to 100 acres (41ha) may be annually treated. The potential for this technique being used extensively is low because

ideal conditions exist only once in 5 to 7 years. Herbicide treatment of upland grasslands and sedge meadow areas has been used more extensively over the past 8 years. This technique is very cost effective ($65 to $100/acre) and has the potential to arrest woody vegetation encroachment for 10 to 15 years. Approximately 100 acres (405 ha) are annually treated.

Roller-chopping of a dry sedge meadow area in 1987 produced positive results in controlling willow, alder, and aspen. The equipment used in this operation, a D8 or larger bulldozer with a roller-chopper drum, is so heavy that near drought conditions are necessary for operation in a wetland environment. An opportunity to use this technique again has not materialized since 1987.

Approximately 450 acres (182 ha) of upland is cropped annually by 13 share-croppers who maintain approximately 220 acres (89 ha) in shrub-free hayland. This is a reduction from 1,300 acres (527 ha) being share-cropped in 1986. Approximately 1,275 acres (516 ha) of upland is maintained in permanent grass. The reduction was implemented to address the scarcity of secure nesting habitat for all species of grassland-nesting birds. A portion of the annual corn crop is left standing at key locations to provide winter food for prairie chickens and other species. In recent years, food patches, consisting of 2 acres (1 ha) of corn and 2 acres (1 ha) of a sorghum-millet mixture, have been planted where traditional farming was removed. This practice was initiated to provide, along with approximately 1,275 acres (516 ha) of permanent grasslands on upland sites, a stable fall and winter food source for prairie chickens.

MCMILLAN WILDLIFE AREA

Booming grounds are present only on private lands adjacent to this 6,500-acre (2,632.5 ha) wetland area which is managed primarily for waterfowl. Some brush mowing is conducted on an irregular basis. The presence of purple loosestrife (*Lythrum salicaria*) within the wet environment of this area precludes the use of most standard vegetation control techniques.

Management Needs

The greatest management need is for an economical, effective, and environmentally acceptable means of controlling the natural succession of woody plants that are constantly converting grasslands to shrubs and trees. Willow, speckled alder, steeplebush (*Spiraea tomentosa*), and aspen are the dominant and persistent invaders of the managed lands.

A prescription for optimum, seasonal habitat components, and methods of creating the same, is needed as a guideline for management units that have booming grounds as the focal point and are composed of lands within a 1-mile (1.6-km) radius (Hamerstrom et al. 1957, Toepfer 1988, Toepfer et al. 1990). A quick and accurate field method of evaluating habitat quality (i.e. optimum grass-forb height, density, and distribution) is needed for managers and field technicians instead of time-consuming procedures of counting stems/unit area or similar quantitative methods.

Research Needs

The primary role of wildlife research is to provide information that can be incorporated into effective management. Initial research results provide facts that beg corroboration that can only be forthcoming through long-term field studies.

There is a pressing need for management-oriented, applied research at this time when wildlife habitat is generally dwindling or being seriously threatened by conversion to other uses in the face of an ever-increasing human population. Permanent grasslands are most vulnerable to conversion or modification because of their potential for providing sites for human facilities and food production. Land acquisition to create grassland reserves commanded the attention, efforts, and financial resources of concerned citizens, and agencies to stem this tide. Little surplus remained of these resources that could be directed towards the determination of optimum seasonal needs of prairie grouse or the design

of procedures and techniques that would facilitate fine-tuning of management efforts to produce and maintain habitat components. Consequently, prairie grouse populations struggled along at low densities, and some disappeared in North America. In spite of these limitations and challenges, monumental research and management efforts have maintained viable populations of prairie grouse that present new and greater challenges for preservation.

Prairie chicken research in Wisconsin and other states has historically focused on nesting and brood-rearing habitat because they are primary management factors that affect productivity. Attention now needs to be focused more sharply on other limiting factors that may be dampening chicken population growth and expression of optimum density.

Many prairie chicken research needs in Wisconsin are currently being addressed by a management-oriented research project entitled *"Prairie Chicken Grasslands: 2000 and Beyond" (PC-2000)*. Initiated in 1996, this enterprising 5-year project, is sponsored by The Society of Tympanuchus Cupido Pinnatus and directed by Toepfer. The study is based in Wisconsin with adjunct study areas in Minnesota and North Dakota. Survival, general habitat use, dispersal, and nesting success are monitored to provide contemporary information which, combined with that of past studies, can provide a life history/habitat model for prairie chickens.

The study is focused on the habitat and landscape surrounding booming grounds on the premise that cocks and hens have an affinity to that site and hence will be the key to management. Toepfer (1988) documented that 90% of 35,000 non-booming ground, prairie chicken locations were within 1.2 miles (1.9 km) of a booming ground but the all-season influence of that site on the movements of the chickens has yet to be clearly defined. Specific objectives for each state study area are:

- ***Wisconsin*** – document present distribution, movements, survival, habitat use, nest and brood-rearing success, and dispersal of prairie chickens 1996–2001.
- ***Minnesota*** – 1) document habitat use, nesting and brood-rearing success and dispersal during the presumed cyclic increase, 1996–2001, and 2) re-establish a prairie chicken population in southwestern Minnesota, 1999–2001.
- ***North Dakota*** – 1) re-establish a second viable prairie chicken population in east-central North Dakota by translocating birds, 1992–99 and 2) develop guidelines for future reintroduction efforts.

Preliminary results from this comprehensive study indicates that nest and hatch success do not appear to be negatively affecting productivity. Therefore, mortality factors, their timing and relationship to habitat, emerge as possibly limiting current productivity. These include disease, parasites, accidents, predation, poor nutrition, pesticides, and adverse weather. The interaction of these factors and their relationship to genetics and habitat creates a complex research problem that will require several years of effort and much financial support. Establishing baseline data, in quest of a productivity-limiting factor, will facilitate assessment of the health and status of chicken populations at any future date.

Several of the above potential limiting factors are currently being addressed within the broad framework of the PC-2000 research project. Recruitment, brood break-up and dispersal are receiving an emphasis of time and effort because little is known about this important aspect of upland game bird ecology. Dispersal distances may be related to habitat quality in the vicinity of a booming ground and the associated nesting and brood-rearing areas. The relationship of dispersal to Hamerstrom et al.'s (1957) original ecological scatter-pattern management concept, and the basic needs of chickens for wide horizons and grasslands, needs to be revisited.

Other priority factors that have received relatively little research attention in the past include: 1) night roost habitat, where chickens spend 8–12 hours each day in one place and at least a third of their entire life, and 2) the philosophy, variety, nutrition, and subsequent management of winter foods in relation to

their being emergency, supplemental, or maintenance in nature. The possible negative aspect of soybeans as a winter food for prairie chickens needs early attention. Raw soybeans have been found to inhibit digestive enzymes and thus depress fat absorption in some upland birds (Bogenschutz et al. 1995).

Effective methods of controlling shrub and tree encroachment on grasslands in this temperate climate need to be developed. The effectiveness and timing of periodic disturbance of chicken habitat by spring burning and cattle grazing need evaluation relative to the nesting, brood-rearing, and night-roosting behavior of the birds.

The composition, abundance, and ecological role of all inhabitants of the prairie chicken grassland ecosystem needs documentation and study. Some yet unknown living component may be a sensitive and reliable indicator of the system's environmental health.

The impact on all grassland wildlife, of pesticides and herbicides applied to agricultural lands adjacent to chicken management lands, needs attention. Pesticides have been shown to drift a minimum of 0.9 miles (1.5 km) from target areas on the Buena Vista Area and may have depressed brain cholinesterase levels of songbirds (Deeley 1980).

Potential sites for expanding Wisconsin's prairie chicken range need identification and evaluation. Some waterfowl management areas in Wisconsin appear to have considerable potential for supporting chicken populations. Similarly, lands on the Buena Vista, Leola, and Paul Olson areas that are currently being managed for prairie chickens, have potential for improving habitat for waterfowl and other wetland wildlife species. This could enhance the support base for chicken management without materially affecting the status of the population.

Land-use maps are valuable for documenting the distribution, quantity, quality, and changes in prairie chicken habitat over time. Today, land-use mapping has been enhanced by high-resolution photography and computerized in a very powerful Geographic Information System (GIS) which lends itself nicely to land management modeling for prairie grouse (Merrill et al. 1999). However, the base data for the maps must be accurate and verified in the field. The resulting maps can only be as accurate as the least accurate data and many are not as accurate as they could, should, or need to be (Wilmore 1996).

Recommendations

1) Initiate the projects identified above in "Research Needs."

2) Continue thorough annual censuses on all areas to obtain reliable indices to habitat conditions, and status and distribution of the chicken.

3) Gradually and cautiously expand spring prairie chicken viewing opportunities to other management areas using the Buena Vista program as a model.

4) Design and conduct a quality, controlled, experimental, spring/fall hunt of prairie chickens on the Mead Area if the population rises to 200 booming cocks and on the Buena Vista Area if that population reaches approximately 500 booming cocks in the future. These areas have the largest amount of public lands to facilitate a tightly controlled, ethical hunt.

5) Secure additional habitat for chickens in the Leola Area to increase and provide for the stability of that population. Do the same for the Buena Vista, Paul Olson, and Mead areas if research shows that such is needed with the changing land-use practices on adjacent private lands, and that existing lands are managed to provide a maximum of quality prairie chicken habitat. This will require a careful evaluation of current burning, grazing, and share-cropping practices.

6) WDNR should continue to pursue the purchase of lands that are currently leased from private organizations as was done recently with the 7,000 acres (2,835 ha)

owned by STCP. This would recycle funds to the several organizations and enable them to expeditiously purchase key parcels of additional land if they so chose.

7) Continue the current management funding level with periodic increments to offset inflation. Provide for replacement of worn equipment to eliminate dependence upon private funding for the same.

8) Lines of communication between research and management segments of the prairie chicken program need to be improved and maintained in order that applicable research results can be quickly incorporated into management programs. The time lag between obtaining meaningful results and ultimate publication in professional journals is much too great because of the necessary peer-review process and subsequent revisions of manuscripts. In addition, many valuable research projects do not qualify for publication in professional journals because of their provincialism. Similarly, we recommend that the Prairie Grouse Technical Council increase its mission of communicating ideas and information between prairie grouse managers and researchers in North America on a more frequent and regular basis.

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Wisconsin Prairie Chicken Management: An Agency Perspective

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Background

The greater prairie chicken *(Tympanuchus cupido pinnatus)* is a grouse species native to Wisconsin. Prior to settlement it was found in the prairies and savannas of the southern third of the state. Large-scale logging, subsequent fires, and pioneer farming in the latter half of the 19th century created temporary open land, and the range of the chicken expanded northward. Around the turn of the century, prairie chickens were actually present in every county, but losses of both native grasslands in the south and newly created habitat in the north were occurring rapidly. Agriculture, tree planting, fire control and natural succession all took their toll. By the middle of the 20th century, the prairie chicken population had plummeted. The bird could then be found only in central Wisconsin.

Wisconsin's commitment to prairie chickens began in 1928 with the very first wildlife research project in the state. This project was conducted by the newly formed Wisconsin Conservation Commission, now the Wisconsin Department of Natural Resources (WDNR). Known as the Wisconsin Prairie Chicken Investigation, this work was completed under the direction of Dr. Alfred O. Gross from Bowdoin College in Maine. Subsequent studies by Aldo Leopold, Franklin J.W. Schmidt, and Wallace Grange also increased knowledge of Wisconsin prairie chicken numbers and habitat needs.

The stage was then set for the pioneering work that would form the basis for future prairie chicken management in Wisconsin. Frederick and Frances Hamerstrom began graduate student research under the direction of Aldo Leopold in the late 1930s and 1940s. They continued their prairie chicken research from 1949–72 working for the Wisconsin Conservation Commission. Together with Oswald Mattson, they published their recommendations for prairie chicken management in Wisconsin (Hamerstrom et al. 1957). The resulting "Guide" outlined the basics for the beginnings of a management program in Wisconsin and warned that the effort must begin within 5 years or the prairie chicken would be lost forever.

Four years before publication of the Guide, the Wisconsin Conservation Commission affirmed its commitment to the prairie chicken by adopting the *"Wisconsin Prairie Grouse Management Policy"* (14 May 1953). This policy statement called for the management and restoration of habitat for prairie grouse in the state.

The prairie chicken would make its stand in central Wisconsin where the best habitat and populations remained. It was here that large-

scale agricultural drainage, beginning in 1905, allowed development of a private land use which prairie chickens found suitable – primarily pasture and an extensive bluegrass (*Poa pratensis*) seed industry.

As a result of the Hamerstroms' work and encouragement, the private sector stepped forward and provided the capital to purchase land specifically for prairie chicken management. The majority of land purchases was made by 2 private organizations committed to the chicken – the Society of Tympanuchus Cupido Pinnatus, Ltd. (STCP) of Milwaukee and the Dane County Conservation League (DCCL) of Madison. These 2 groups did their jobs well. Initial purchases earmarked for prairie chicken management were made in 1954, and land acquisition was in full swing by 1961. Through the 1960s and into the 1970s nearly 14,000 acres (5,600 ha) of land were purchased in central Wisconsin for grassland management based on Hamerstrom's "ecological patterning" proposal outlined in the "Guide." This proposal called for ownership and management of scattered parcels ofgrassland rather than 1 large contiguous block.

Habitat Management

Research, the management commitment, and land acquisition were then combined into the beginnings of Wisconsin's Prairie Chicken Management Program – a program that has successfully preserved the prairie chicken in Wisconsin. Oswald Mattson became the project's first manager, and the program began to implement the recommendations from the "Guide." Management was geared to provide permanent grassland for nesting and brood rearing as well as dependable winter food and cover to support the prairie chickens year-round.

Management in the early 1960s concentrated on newly acquired acreage that had been reverting to brush and timber. Bulldozers, chainsaws, rotary mowers and broadleaf herbicides were all used to restore grasslands. By the mid-1960s, prescribed fire was also being used to stimulate grass and retard brush invasion. As additional acreage was purchased, the management effort was expanded to keep pace. Throughout the late 1960s and early 1970s, a major grassland restoration effort was accomplished largely with bulldozers and herbicides. By 1975, a large portion of the land acquisition had been completed and work on the acreage needing grassland restoration had been done. Management then moved into a second phase – one of grassland habitat improvement and maintenance to be accomplished through a rotational pattern of disturbance. This disturbance phase forms the basis for the current grassland management program.

One of the original goals of prairie chicken management in Wisconsin was the prevention of brush invasion into the grassland habitat. This remains an important goal, and management techniques are designed to control woody vegetation. Without management, most acreage on Buena Vista Grasslands would quickly change to brush and timber and prairie chicken habitat would be lost. However, we can no longer be satisfied with simply maintaining a certain acreage of publicly owned property in "grass." Changes on surrounding private lands will continue, and management practices that were adequate yesterday may not be adequate tomorrow. Our goal is to make every grassland acre of managed property as productive and beneficial for the prairie chicken as possible. This requires knowledge of grassland habitat and proper techniques for maintenance and improvement. It also requires knowledge of the prairie chicken and its habitat needs throughout the year.

The prairie chicken in Wisconsin has been described as "probably the most intensively managed grouse in North America" (Bergerud and Gratson 1988). Much has been learned from research that began in the 1920s and from previous grassland management efforts that began in Wisconsin with initial land purchases in 1954. The habitat management program has been fine-tuned from the early years and has incorporated some new techniques, but the principles outlined in the "Guide" still apply. Periodic disturbance of grassland acreage remains as the basic underlying concept.

Native grassland habitats evolved with natural and periodic disturbance. This disturbance had a much needed and positive effect on plant diversity as well as the productivity of plant and wildlife species. Several management practices, applied at appropriate intervals, are now utilized to simulate effects of natural disturbances. These practices include burning, grazing, planting, mowing, disking, and haying. Broadleaf herbicides continue to be used for additional control of woody vegetation encroachment, but at a level much reduced from that of the past.

The size of each disturbance (management operation or practice) is kept to the minimum that is practical. For example, prescribed fire and grazing are implemented on 80 to 120 acre (23–49 ha) units. Farming operations are conducted within 20-acre (8 ha) parcels. Disturbance is distributed throughout the property, and each type of disturbance is also scattered. This assures that habitat benefits are distributed and available throughout the range.

An annual spring census of males on booming grounds is conducted throughout the prairie chicken range. The goal is to obtain a 100% count of all displaying males. Over time, this count provides a gauge to population levels and distribution, as well as a check on effects of habitat management and surrounding private land use changes (Table 1).

We use known locations of prairie chicken booming grounds (primary breeding sites) as focus points for habitat management. In general, females will find nesting habitat within a 1-mile (1.6 km) radius of booming grounds. Ideally, brood habitat should also be available close by, as should all other habitat requirements. Our investment to provide quality grassland within this radius is a priority. We can presume that if adequate habitat was not available, there would be no hen activity and, therefore, no booming ground in that location.

Table 1. Displaying male prairie chickens on Buena Vista and Leola Grasslands in central Wisconsin (Merrill 1997).

Year	*Buena Vista*	*Leola*	*Total*
1968	139	12	151
1979	438	53	491
1985	275	69	344
1989	182	64	246
1997	324	97	421

Today the Prairie Chicken Management Program includes 3 wildlife areas in central Wisconsin; Buena Vista Grasslands, Leola Grasslands, and the Paul J. Olson Wildlife Area. Two other WDNR properties, the George W. Mead and McMillan Marsh Wildlife Areas, are managed primarily for waterfowl, but because of extensive sedge meadow habitat and associated uplands, they offer significant prairie chicken benefits as well.

The WDNR purchased lands owned by STCP (largely on Buena Vista Grasslands) in 1988, and deed restrictions require that these lands continue to be managed for prairie chickens. Funds received by STCP from this purchase have been designated for continued support for management and research of prairie chickens and other threatened and endangered species in Wisconsin. Land acquisition has continued with the purchase of 940 acres (381 ha) on Leola Grasslands in 1992. An additional 920 acres (373 ha) have been purchased on Buena Vista Grasslands during 1996–98. Today, over 16,000 acres (6,480 ha) are managed on these 3 properties for prairie chickens in central Wisconsin.

These managed lands in central Wisconsin provide diversity by maintaining grassland habitat in an area of the state that is primarily forested or agricultural. Further, the large block sizes and total acreage of grassland established and managed for prairie chickens have been a great benefit to many other grassland wildlife species. Although most of these grasslands are not composed of native plant species (they are actually referred to as "surrogate" grasslands), they do provide the vegetative structure needed by many birds and small mammals whose numbers are of

serious concern in Wisconsin. For example, the eastern meadowlark (*Sturnella magna*), upland sandpiper (*Bartramia longicauda*), and Henslow's sparrow (*Ammodramus henslowii*) are found in abundance in these grasslands. In 1997, the regal fritillary butterfly (*Speyeria idalia*), a Wisconsin endangered species, was also found.

The challenge that has been accepted in applying the Wisconsin Prairie Chicken Management Program is two-fold. First, to blend the available budget, the habitat needs of the prairie chicken, our knowledge of grasslands, and the impacts of management practices on this increasingly rare ecosystem. The result of this blend must be a workable management effort. Secondly, to maintain management flexibility dictated by constant change in the surrounding landscape, to incorporate appropriate new ideas as they arise, and to continue to improve the effort to provide the best possible grassland habitat for our remnant prairie chicken population. It is believed that the current level of population security can be maintained for the immediate future with today's grassland management program. However, additional grassland acreage may be needed to maintain this level of security for the long-term. Lack of suitable grasslands beyond the boundaries of the present range prevents population expansion.

One new potential involves an attempt to develop, improve, and maintain grassland habitat on *private lands*. To date, all efforts have been focused on publicly managed grasslands. Targeting privately owned property through the use of financial incentives for landowners contained in the 1995 Farm Bill may provide suitable habitat for prairie chickens where none presently exists. Partners in this new venture include the Natural Resources Conservation Service, the U.S. Fish and Wildlife Service, and the WDNR.

While states east of Wisconsin have lost their prairie chickens, we are "holding the line" against the westward march of extirpations. Our ultimate goal is to maintain a viable population of prairie chickens in this state through the most appropriate and cost effective means available. The work is not done. New threats to long-term habitat security will present constant challenges to the survival of the species. As long as these challenges are met, these wide horizons hold a genuine future for Wisconsin's prairie chickens.

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Status and Management of the Greater Prairie Chicken in North Dakota

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Historical Review

Long-term residents of North Dakota witnessed the nearly complete history of greater prairie chickens (*Tympanuchus cupido pinnatus*) in the state. The rise and fall of this elegant immigrant species took place in less than 80 years. All accounts of "prairie chickens" prior to 1870 were in reference to sharp-tailed grouse (*Tympanuchus phasinellus*) because prairie chickens were not present in the state at that time.

The range of the prairie chicken has been unstable during the past 200 years. A native of tallgrass prairies, and more truly a grassland species than the sharptail, it was found in great numbers in eastern sections of the United States in the early 1800s. As human settlements sprang up in midwestern sections of the continent, prairie chicken populations showed remarkable increases. When there were large populations of chickens in eastern states, birds were scarce or absent farther west. By the time prairie chicken populations built up in the Midwest, birds were already decreasing along the East Coast.

The exact date of the prairie chicken's arrival in North Dakota is not known but appears to have coincided with destruction of the immense bison herds and establishment of the first white settlements. Since the bird followed man's agricultural activities, there were human observers nearby when prairie chickens moved into the state. Coues (1874) reported that he did not find the prairie chicken at Pembina in 1873 but did relate that between Yankton and Fort Randall both chickens and sharptails were present. Above Fort Randall all grouse were sharptails and he wrote; "I have no reason to believe that it (the prairie chicken) occurs at all in northwestern Minnesota or northern Dakota where the other species (sharptail) is so abundant. Its progress upon the Missouri River has been traced by Dr. Hayden farther than by myself to the Niobrara; and that writer adds that it may proceed to the White River."

A few years later, Cooke (1888) mentioned that the prairie chicken was 40 miles (64 km) from the southeastern corner of North Dakota at Herman, Minnesota in 1879, and, by the early 1880s, the species was occupying a strip 30–60 miles (48–96 km) wide along the Red River over the whole eastern edge of North Dakota. Spring booming of prairie chickens was reported as early as 1884 at Barton, North Dakota, a considerable distance west of the "strip," so some birds were already extending beyond the recognized range.

Thus it appears the prairie chicken first showed up in notable numbers in North Dakota along the Red River Valley in the early

1880s. In 15 to 20 years, this species spread across the state with the Badlands being the only area where chickens were not sighted at one time or another during the past 100 years. Present (1997) estimated spring breeding populations of prairie chickens in North Dakota are about 300 with most living on or near the Sheyenne National Grasslands (SNG) in southeastern North Dakota or the vicinity of the Prairie Chicken Wildlife Management Area (WMA) in Grand Forks County.

Table 1. Prairie chicken harvest in North Dakota, 1938–42.

Year	*Birds per hunter*	*Number of grouse harvested*	*Total estimated population*
1938	1.2	29,000	300,000
1939	1.2	45,000	350,000
1940	1.2	47,000	450,000
1941	.8	40,000	420,000
1942	.7	36,000	400.000

Table 2. Prairie chicken census, Sheyenne Grasslands, 1961-70.

	Ground number								
Year	1	2	3	4	5	6	7	8	Total males
1961	*	*	*	1	4	*			5
1962	0	*	0	1	6	0	2	*	9
1963	*	*			9	*		*	9
1964									
1965					4				4
1966					3	0			3
1967									
1968					0	0			0
1969	7				0				7
1970					2	1			3

** Booming ground was heard or plotted, but not censused. No counts were made in 1964 or 1967.*

Now that the prairie chicken is gone from many places, practically everyone, in retrospect, proclaims it to be one of the finest of game birds. There were numerous attempts to restock this species in the East before 1900 and many chickens were transported and released in foreign countries. All early attempts at stocking and restocking were unsuccessful. At the present time, the prairie chicken plays practically no role to the sportsman, farmer or nature lover of North Dakota. Prairie chickens arrived, thrived, and faded into obscurity all in a period of about 60 years.

Large, spectacular harvests of this bird in North Dakota were a thing of the past before anyone attempted to estimate annual harvests. North Dakota Game and Fish Department (NDGFD) files show only 5 years of harvest figures for prairie chickens covering the period 1938–42 (Table 1).

Many factors which influence sharptail populations also affect prairie chickens. In fact, changes in specific land-use practices affected chickens more directly than sharptails. The prairie chicken was an immigrant species and declined more rapidly and markedly when land-use changes took place.

Like the bison, it has often been repeated, the prairie chicken was a species exterminated by hunting. While year-round hunting helped reduce chicken populations, land-use changes (burning, plowing, and grazing) were more important in the long-term population decline.

Undoubtedly, the biggest hunting harvest of prairie chickens occurred in the period 1890 to 1930. Probably more birds were killed per hunter during the early part of the period. As time went by, greater numbers of hunters with better methods of transportation and more efficient weapons increased the overall harvest.

The last open season for this bird in North Dakota was in 1945. Before that time seasons and regulations were the same as for sharptailed grouse. Because prairie chickens did not immigrate into North Dakota until the 1880s, seasons and regulations pertinent to the species covered a period of about 60

years, or from 1885 to 1945. Since prairie chickens did not become common in the western half of the state until about 1900, regulations there were important for less than 50 years. Small areas in the eastern portion of the state have been completely closed to all grouse hunting since 1942, with the exception of 1965-67.

When the great populations of prairie chickens began to decline during early settlement days, it was understandable that seasons and regulations were employed in an effort to stop the decline. Many people believed that once hunting was stopped birds would reproduce and return to their former large numbers. But there were other important considerations. Seasons and regulations are always intangible items left up to individual judgement. All too often, promiscuous killing continued. Secondly, and more important, human populations were rapidly increasing and, with this increase, chicken habitat changed greatly. Man was constantly altering the habitat to fit his needs; as a result the grouse population declined.

Many changes in seasons and regulations were introduced in an attempt to stop this decline. Market hunting, use of nets and traps, and large gauge guns were outlawed. Bird dogs were prohibited. Shooting hours were reduced to daylight and sometimes to only a few hours each day. Nonresident hunters were restricted or closely regulated. Many local, specialized regulations were enforced. And finally, the state was completely closed to hunting prairie chickens.

Table 3. Prairie chicken census, Sheyenne Grasslands, 1971-97.

Year	Grounds visited	Active grounds counted	Total males	Males/ active ground
1971	6	5	20	4.0
1972	15	12	68	5.7
1973	20	14	89	6.4
1974	17	14	78	5.6
1975	25	23	139	6.0
1976	29	20	139	7.0
1977	33	24	188	7.8
1978	31	22	195	8.9
1979	48	36	338	9.4
1980	49	38	410	10.8
1981	29	17	137	8.1
1982	37	28	223	8.0
1983	40	34	396	11.7
1984	28	26	313	12.0
1985	43	27	262	9.7
1986	22	22	173	7.9
1987	39	24	220	9.2
1988	50	35	257	7.3
1989	55	27	190	7.0
1990	57	28	206	7.4
1991	48	25	171	6.8
1992	48	25	205	8.2
1993	42	26	142	5.5
1994	55	18	84	4.7
1995	56	21	95	4.5
1996	41	19	144	7.6
1997	31	11	69	6.3

Census Procedures and Reintroductions

Annual spring booming ground counts are made to census all known prairie chickens in North Dakota. Currently the census is concentrated in 4 areas: SNG; Prairie Chicken WMA; Englevale WMA; and southwestern Sargent County.

A census has been conducted on the SNG since 1961. From 1961 through 1970 not all grounds were visited, some were merely plotted, and in 2 years, no census was conducted (Table 2). The census has been more complete since 1970; at least it was conducted each year (Table 3). Complete coverage was lacking in some years, particularly in 1981. It is evident the population reached a peak in 1980 but declined since that time and, in 1997, the population had fallen back to the 1972 level.

A population of sharp-tailed grouse also exists on the SNG (Fig. 1). Unfortunately, a com-

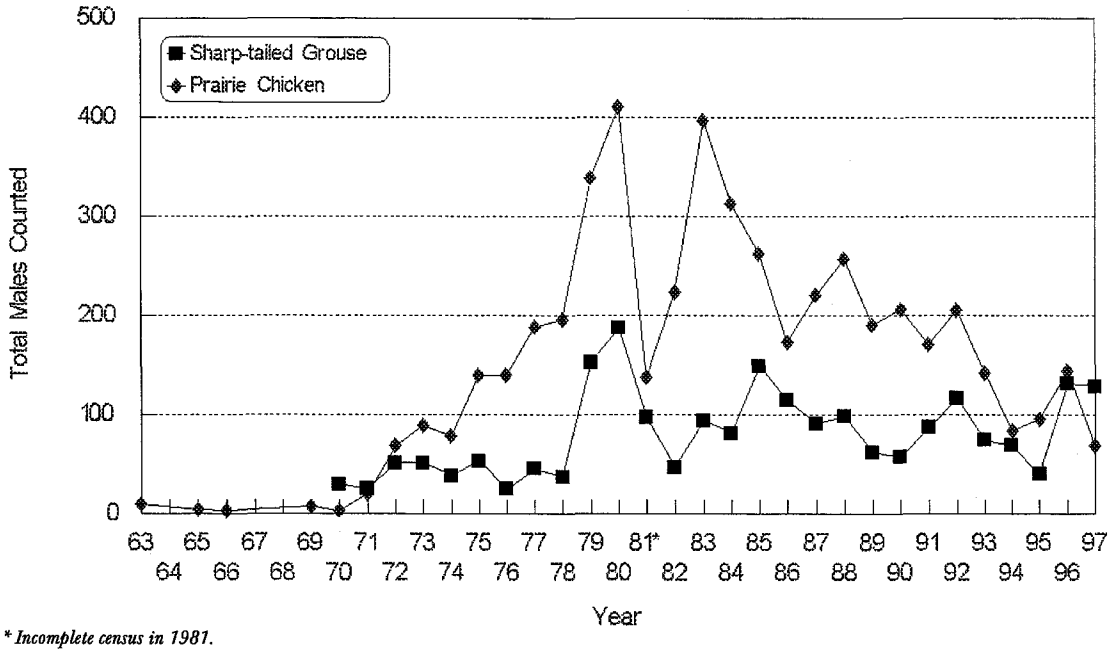
plete census of this species has never been made, but enough grounds have been counted to show a population trend. Counts of sharptails were started in 1970 but were very incomplete until 1979. Trend lines (Figs. 2, 4) from the beginning of counts of both species show an increasing trend; however this is due to extremely low, incomplete counts during the first 10 to 16 years of census (Fig. 4). The trend of prairie chickens over the last 20 years is down significantly (Fig. 3). The sharptail trend is also down over the last 19 years, but not significantly (Fig. 5).

A small population of prairie chickens exists in southwestern Sargent County, but most of the birds in this vicinity are in South Dakota. However, 1 ground in North Dakota has been active for the past 6 years with males varying from 2 in 1992 to 8 in 1996. A greater census effort could result in more grounds being found in this area.

A spring release of 55 wild-trapped prairie chickens from Nebraska was made in 1993 near the Englevale WMA. These birds have been censused and radio tracked since that time. Some nests were found in the immediate vicinity, but some radio-marked birds moved long distances including at least 5 females that moved to the SNG more than 20 miles (32 km) away. Radio tracking ceased as radios failed but a spring census indicated some prairie chickens remained in the area until 1996. No prairie chickens were seen here in spring 1997.

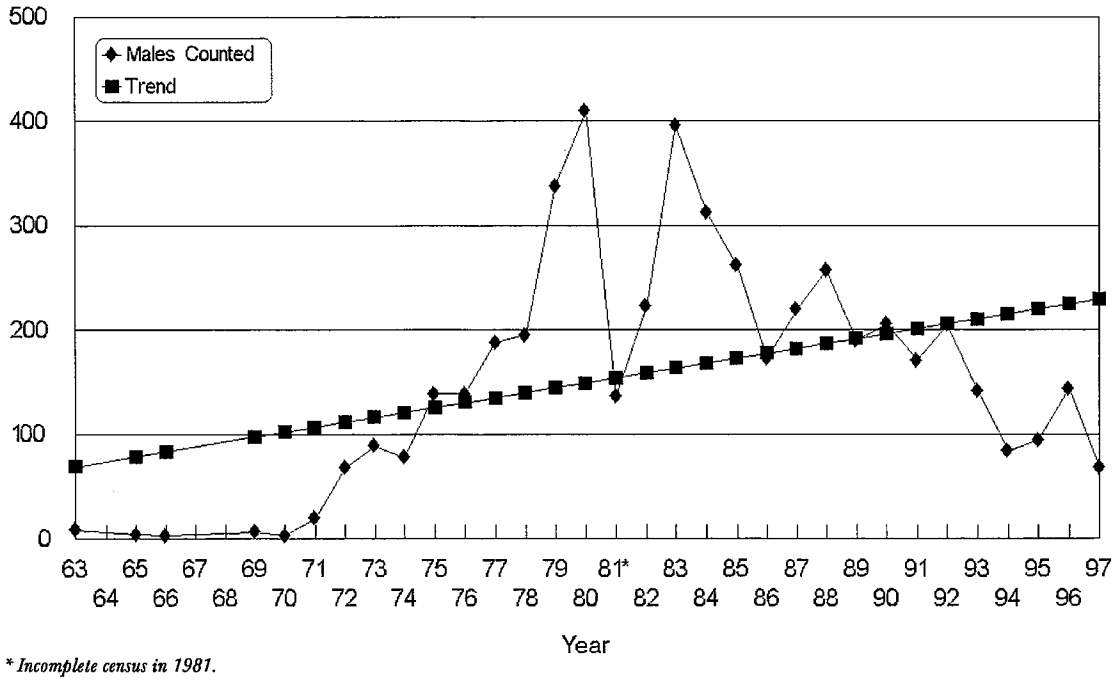
Our greatest effort in reestablishing prairie chickens in North Dakota has been on the Prairie Chicken WMA. Prairie chickens were present on this area in 1968 when the first land purchase of 160 acres (64 ha) was made by the NDGFD. By 1977, more than 3,150 acres (1,260 ha) had been purchased. Acquisition has been slow since that time with only 320 acres (128 ha) acquired in the last 20 years. There are additional acres in wildlife habitat and, while not acquired or managed for prairie chickens, provide some prairie chicken habitat. These include 1,300 acres (520 ha) managed by the State Land Department and 7,766 acres (3,106 ha) administered

Figure 1. Male prairie grouse counted on Sheyenne National Grasslands, North Dakota, 1963–97.



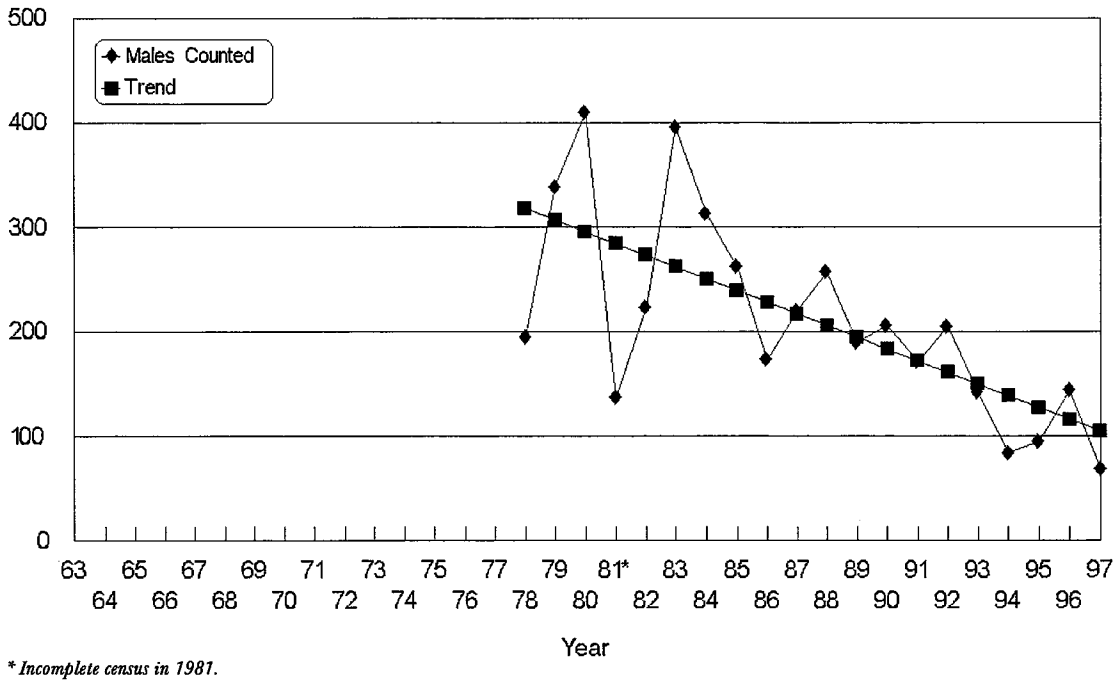
** Incomplete census in 1981.*

Figure 2. Male prairie chickens counted on Sheyenne National Grasslands, North Dakota, 1963–97.



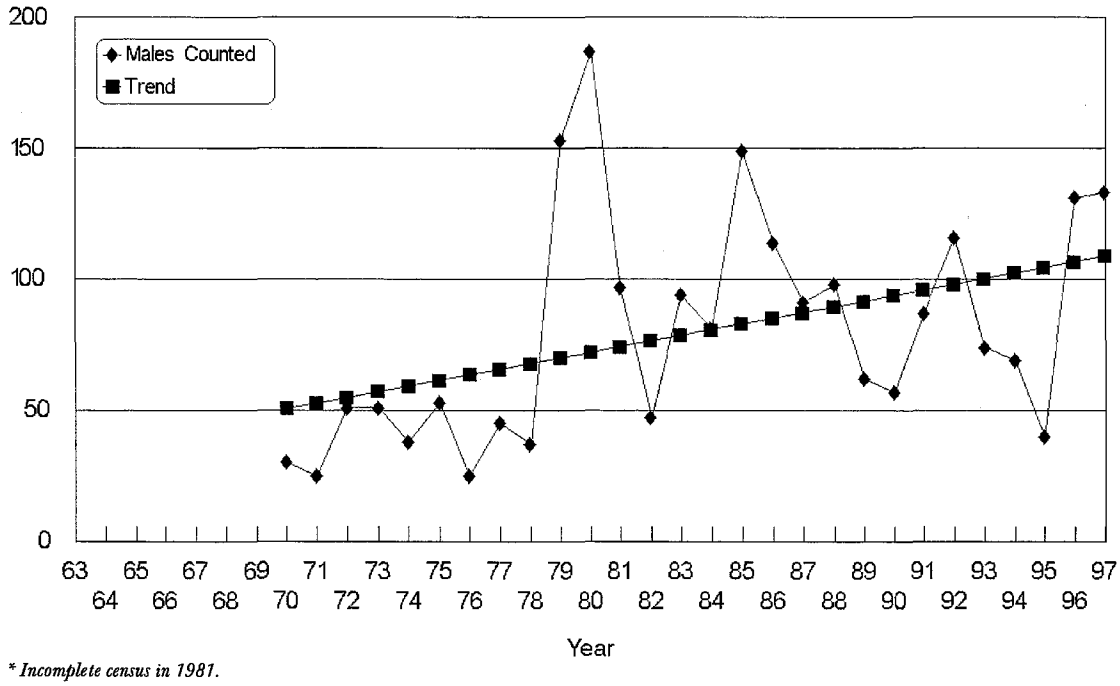
** Incomplete census in 1981.*

Figure 3. Male prairie chickens counted on Sheyenne National Grasslands, North Dakota, 1978–97.



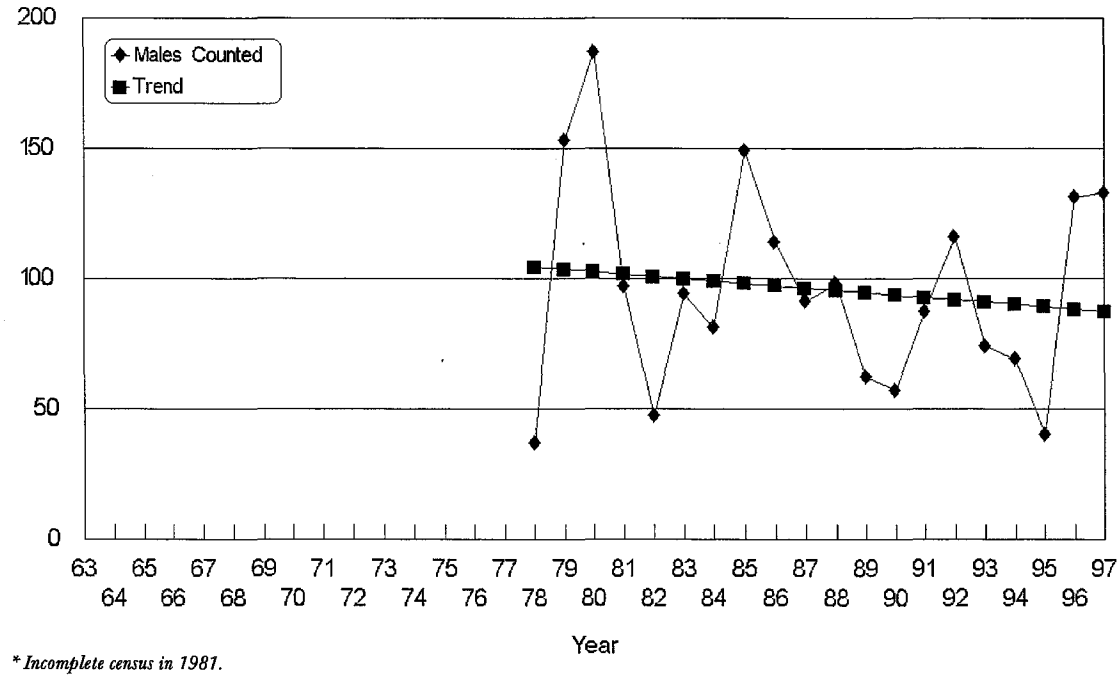
** Incomplete census in 1981.*

Figure 4. Male sharptails counted on Sheyenne National Grasslands, North Dakota, 1970–97.



** Incomplete census in 1981.*

Figure 5. Male sharptails counted on Sheyenne National Grasslands, North Dakota, 1978–97.



** Incomplete census in 1981.*

by the U.S. Fish and Wildlife Service.

A census of the Prairie Chicken WMA actually began in 1954 when 11 males were counted. An annual census was begun in 1965 and has continued until 1997, even though prairie chickens disappeared in 1980. An annual census was continued because sharptails were also present. Sharptails first appeared on census sheets in 1972 but were certainly present before that year since 52 males were counted in 1972. Sharptails peaked in 1981, 1 year after the prairie chicken disappeared, but by 1992, sharptails were also gone.

Though both species of grouse have vanished, it was felt that this area had the potential to support prairie grouse. First; Conservation Reserve Program (CRP) acres reached a peak of nearly 34,000 acres (13,600 ha) within a 6-mile (9.6-km) radius of the Prairie Chicken WMA, providing excellent grassland habitat. Second; management of NDGFD acres was intensified (burning, grazing, brush control, food plots). And third; the Fish and Wildlife Service formulated the Kelly Slough Management Plan which included habitat management for prairie chickens and funds for reintroduction. This area seemed to have all the ingredients for a successful transplant; habitat management was underway, a past history of resident prairie chickens, a viable population only 30 miles (49 km) away in Minnesota; and several willing cooperators ready to lend funds and support materials.

The first transplants were made in summer, 1992. Recent releases have been in spring with the final release planned for spring 1998 (Table 4). A spring census has shown a steady increase in both male prairie chickens and number of booming grounds (Table 5). An annual spring census will continue but no intensive brood surveys have been conducted and none are planned.

Hunting

Habitat for greater prairie chickens in North Dakota is limited and the species is listed as *state threatened*. It is not hunted, thus there are no hunter bag checks or harvest surveys. It is listed as an upland game bird and may be

Table 4. Summary of prairie chicken transplants to North Dakota.

Year	Season	Origin	Release site	Prairie chickens released			
				Males	Females	Uknown[1]	Total
1992	Summer	Minnesota	Grand Forks	12	17	—	29
1993	Spring	Nebraska	Englevale	27	27[2]	—	54
	Summer	Minnesota	Grand Forks	14	16	—	30
1995	Summer	Minnesota	Grand Forks	24	19	6	49
1996	Spring	Minnesota	Grand Forks	4	0	—	4
	Summer	Minnesota	Grand Forks	28	0	—	28
	Summer	South Dakota	Grand Forks	6	12	10	28
1997	Spring	Nebraska	Grand Forks	36	55	—	91
1998	Spring	Nebraska	Grand Forks			—	100[3]
Total birds transplanted				151	146	16	313

1. *Chicks, sex unknown.*
2. *Five of these hens were moved to Grand Forks during Summer 1993.*
3. *Proposed transplant, not included in total.*

Table 5. Recent results of prairie grouse census, Grand Forks, North Dakota, 1993–97.

Ground	1993	1994	1995	1996	1997
1	4	6	12	9	11
2					4
3					4
4[1]					0[2]
5					7
6[1]				5	11
7				7	6
8				2	1
9[1]					4
10[1]					5[2]
11[1]		1			0[2]
Totals	4	7	12	23	53

1. These grounds are outside the established census area.
2. These grounds also had sharptail males present.

hunted on a limited permit basis in the future, provided the population increases sufficiently.

Species Needs

When a wild species takes a drastic dip in numbers and does not recover, as occurred with the prairie chicken in North Dakota, we hear a score of reasons offered for the decline. Each critic is convinced their pet belief is the primary limiting factor for the species.

Huge flocks dwindled because man simply went about the business of making a living and intensifying land use. As the country was settled, areas of the nation — east to west — went through a period of high prairie chicken populations. There was a certain point in utilization of the land when habitat and food supply were in balance for prairie chickens. The prairie chicken has been called more of a grassland bird than the sharptail and flourished with some farming, but when the intensive farming stage was reached and few grassland areas remained, the prairie chicken diminished rapidly. Promiscuous hunting may have speeded up the process, but, like the buffalo, the prairie chicken was doomed by man's intensifying land use.

Trained game managers agreed that the most important prerequisite for prairie chickens, as for all wild species, is suitable habitat. There was a difference of opinion as to what was proper habitat and management in the 1800s. Roosevelt (1885), Cooke (1888), and Hatch (1892), among others, stated that the prairie chicken kept pace with settlement of the country and tolerated more grain farming than the sharptail.

Fire has long been condemned as a decimating factor on prairie chickens. The prairie fire was described as the pinnate's "most deadly enemy" particularly in spring when it "destroys every nest within its sweep" (Judd 1905). However, early spring burning, before birds nested, was permissible. Fire during the nesting season was a major problem in conservation of the birds and fall burning destroyed food supplies and winter cover.

Modern research has shown that burning is not necessarily destructive to the prairie chicken and, in fact, has proven to be an important management tool in reestablishing many plants utilized by prairie chickens as food and/or cover. Completely undisturbed areas of grassland which grow tall and dense over a period of years do not furnish all the necessary food and cover requirements.

Observers who have rated weather an important factor in reducing prairie chicken populations are quick to condemn a cold, damp spring, or heavy rains at hatching time, to cause few and/or small broods.

Many observers have stressed that prairie chickens do not renest as commonly as pheasants, partridge and other species. This was one reason that first nesting attempts were believed so important to reproduction for a given year and those who observed chickens hoped for favorable weather in spring.

There are few references to winter losses of prairie chickens in North Dakota. Black (1929) mentions homesteaders who endured

unusually cold winters in the 1880s. One old timer spoke of a bitterly cold 26 April (in 1884 or 1885) when they "found a number of prairie chickens frozen" along with other birds. He did not state whether the mortality was caused simply by the cold itself or a layer of ice that sometimes entraps ground roosting birds.

Since this bird feeds largely on the ground and is not known as a "budder" like the sharp-tailed grouse, it is possible that chickens may have suffered from a lack of food in North Dakota in the past. However, it is important to realize that prairie chickens migrated south from northern states in the fall. These migrations were more obvious when there were large populations. Reasons offered for migrations were that birds were traveling to reach areas of greater food supply and to escape the cold. Several observers using trapping records found that longest flights were made by females and young of the year. There is little evidence of fall migrations in North Dakota during the past 50 years (Bent 1963).

In addition to widely publicized deficiencies of food and cover, many other decimating factors have been blamed for the decline, including over-hunting and predation. The overall population of predators may not have changed much the past 50 years but the proportion of certain ones has changed. Condemned as limiting prairie chicken populations have been the coyote, bobcat, fox, weasel, mink, hawk, owl, and feral dogs and cats. Nest robbers implicated were raccoons, skunks, crows, and other species. Because the coyote was so common at the time chicken populations were rapidly declining, much criticism in the past was directed to it.

Young observers today may not have thought much about the pheasant as a strong competitor with prairie chickens, but many old-timers firmly believed the pheasant had much to do with limiting chicken populations. Others considered their competition a minor factor (Shrader and Erickson 1944).

Many outside factors such as cycles, inbreeding, and others, were condemned from time to time as reducing populations. But the chief cause recognized by most persons is the same one recognized today – prairie chicken populations declined because of destruction or alteration of their environment.

The greater prairie chicken, a tallgrass prairie species, will never expand its range significantly in North Dakota. North Dakota is a semi-arid, short to midgrass state and the habitat will never be suitable for prairie chickens except in isolated tracts, primarily in the eastern part of the state. Since the species was not native to the state, intensive management and preservation of areas such as the SNG is a must if the species is to remain in North Dakota.

Management Needs and Recommendations

Many early management measures designed to save wildlife populations in North Dakota were aimed at prairie chickens. Most early attempts were in the form of hunting regulations. Restrictions on market hunting, bag limits, closed seasons, and various gun, dog, and trespass laws were just a few. These tangential attempts to aid prairie chickens may have slowed the decline but did not halt it or restore populations to former numbers.

Following the first hunting regulations for prairie chickens in the 1800s, the next attempts to manage this species came when private, state and federal refuges were established in many parts of the United States. On these undisturbed lands, varying in size from a few to several thousand acres, prairie chickens could theoretically reproduce unmolested by the hunter, plow, and domestic livestock. Unfortunately, prairie chickens did not respond to any marked degree on these refuges; in most cases populations declined, although many other wildlife species benefitted considerably from this undisturbed habitat. The U.S. Fish and Wildlife Service conducted an experimental program of trapping prairie chickens in South Dakota and releasing them on refuges (J. Clark Salyer Refuge in North Dakota) where habitat appeared suitable for reproduction.

A program to lease 80-acre (32 ha) plots of land already inhabited by prairie chickens was started by the NDGFD in 1955 but was short-lived. It was quickly realized that the project would be too costly and landowners were reluctant. Only 87 acres (35 ha) from a proposed 1,500 acres (600 ha) were leased and the program was discontinued within 3 years.

Mid- to tallgrass prairies are the vital ingredient to survival of prairie chickens. In North Dakota, the original area of tallgrass prairie was in the Red River Valley in the eastern tier of counties. Few of those acres remain today. Two areas, the Prairie Chicken WMA and the SNG are the only areas left where prairie chickens now exist and stand a chance of persisting for any length of time. These 2 areas are vastly different even though both provide habitat for prairie chickens.

The Prairie Chicken WMA is nearly all acquired land that had been in crop production but has been returned to grass. The 3,500 acres (1,400 ha) purchased by the NDGFD were primarily for prairie chickens and continue to be the core area where management is carried out. In recent years, burning, grazing, brush control, food plots and other management has intensified to provide suitable habitat for transplanted birds and must be continued to ensure that birds survive here. The Prairie Chicken WMA is not large enough by itself to provide a secure self-sustaining population. A survey of the 34,000 CRP acres needs to be made to determine those areas used by chickens, determine how many more acres are needed, and try to work those into the prairie chicken management plan. This would involve maintenance, management, and possible acquisition of some CRP lands. We need to work more closely with the Fish and Wildlife Service and State Land Department to point management of their lands in the prairie chicken direction.

Eng et al. (1986) following a study of prairie chickens on the SNG made the following management recommendations:

> *More intensive annual censuses should be conducted. Time should be allotted for conducting listening runs each spring to locate new grounds. The spring inventory must be maintained at a level to detect changes in distribution and relative abundance of both species of prairie grouse.*
>
> *Lowlands and midlands received the most use in winter, spring use by all hens, and summer use by brood hens. Most nesting occurs in lowland or midland communities. Initial nests were less successful than renests indicating a lack of suitable residual vegetation in early spring. No nests were in upland grass or mowed lowland communities. Lowlands and midlands are very important as roosting areas. Thus, modification in management of these 2 communities could have the greatest positive impact on prairie chickens.*
>
> *The mowing pattern of lowlands needs to be adjusted to provide a wider distribution of unmowed lowlands. An effort must be made to increase total amounts of residual vegetation left for nesting and winter roosting. Currently, mowing is done on a block basis with all lowlands in a single pasture being mowed. Disturbance of rank vegetation is necessary to protect upland vegetation but a pattern of mowing and burning that leaves some residual vegetation in each pasture would be beneficial to prairie chickens. One scenario would be to mow a third of each pasture in a 3-pasture allotment on a 3-year rotation basis. A second alternative would be to evaluate individual allotments relative to number of grouse present. Allow mowing practices to remain the same in areas within a 1-mile (1.6 km) radius of booming grounds with high numbers of birds, while adjusting mowing practices around booming grounds with low or unstable numbers. No areas should be mowed more than once every 3 years. The midland strip around lowlands should be excluded from mowing in most cases.*
>
> *Delay mowing of lowlands until 10 August. This will ensure all nesting activities are complete and broods will be mature enough to avoid mowers.*
>
> *Delaying an introduction of cattle into pastures until 15 June would be desirable to*

permit early vegetation growth for early hatching broods. Alternatives would be to delay cattle introductions until 1 June or distribute cattle evenly between pastures during the first 2 weeks. Undisturbed vegetative growth in all pastures would be advantageous to broods hatching in early June.

Maintain areas of vegetation for brood rearing that were heavily disturbed the previous year but are relatively undisturbed in the current summer. Prairie chickens showed a decided aversion for pastures with cattle present. It is unknown whether this aversion was due to presence of cattle or reduction in vegetation from grazing.

To provide a more dependable winter food source, food plots (standing corn, sunflowers) should be strategically located with respect to known wintering areas and booming grounds. Availability of food is influenced by snow amounts and distribution. Food in harvested grain fields is available only when those fields are basically snow free.

Sharptails are present on the area and were found to use shrub habitat at a rate 3 times greater than prairie chickens. Shrub control can be implemented to favor prairie chickens. Juxtaposition of various cover ingredients, food sources for various times of the year, and brood habitat needs to be understood. Use of herbicides for noxious weed control, brush control, and improved forb production, along with use of fire and mowing to improve prairie chicken habitat needs to be investigated.

The major threat to the greater prairie chicken is habitat destruction associated with human activity and livestock grazing. To ensure future survival of the greater prairie chicken, adequate habitat must be provided and protected, and condition of the population and habitat must be continuously monitored to maintain an appropriate balance.

Several research projects appear needed. Biological effects and economics of application of various herbicides for controlling brush invasion and noxious weeds should be examined. There is a need to determine if properly spaced food plots within the grasslands would increase or maintain chicken populations where seasonal food availability is suspected to be the limiting factor. The function of agricultural lands adjoining the SNG as brood-rearing cover and as a food source should be examined.

Acknowledgments

Much of the text for this report was taken from *Feathers from the Prairie* (Johnson 1964). That publication was updated in 1989 (Johnson and Knue 1989) and some information was used from the update. Census and transplant data were updated to make all information current through 1997.

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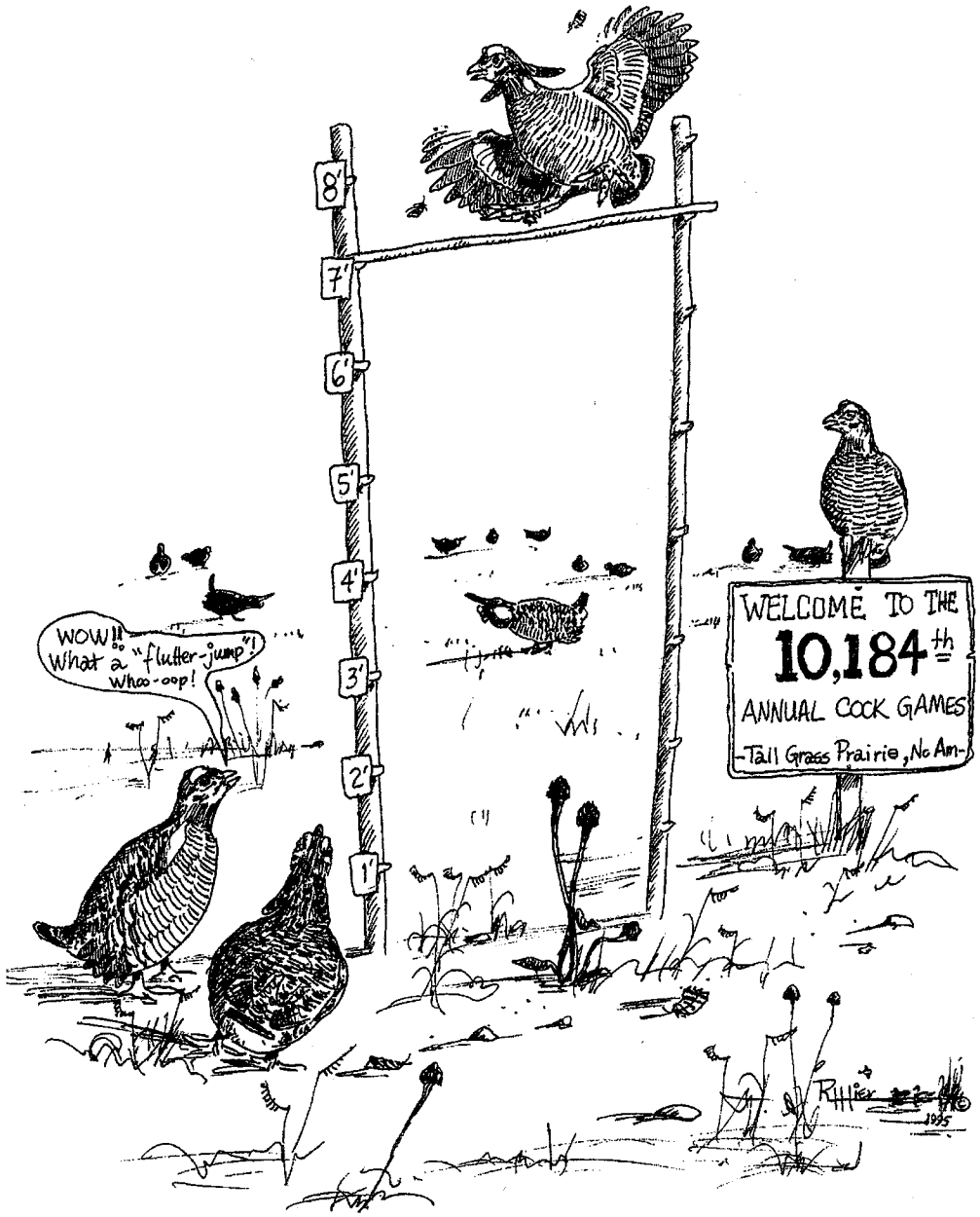

Status and Management of the Greater Prairie Chicken in South Dakota

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Historical Review

Greater prairie chickens (*Tympanuchus cupido pinnatus*) were generally thought to have come into South Dakota in the 1870s following settlers and the planting of grain (Cooke 1888, Johnson 1964). From 1870 to 1900, market hunters reaped a rich harvest (SDDGFP 1958–59). At that time, the area of the Great Plains that included eastern South Dakota was known as "the chicken country." "Millions of chickens and grouse were killed, and settlers were indifferent to or assisted in the slaughter" (SDDGFP 1958–59). However, Kirsch and Kruse (1973) provided convincing evidence that this species was present on the prairies of the Dakotas and Montana after the great reduction in grazing by big game herds, especially bison, but well ahead of the introduction of grain farming (Westemeier 1980). Additionally, Lewis and Clark saw numbers of prairie hens in the Big Bend area along the Missouri River in 1804 (Lewis 1814) and John James Audubon recorded prairie chickens in that area on 26 May 1843 (Audubon 1960). Audubon painted both species (prairie chickens and sharp-tailed grouse [*Tympanuchus phasianellus*]) of prairie grouse so he knew the differences well.

During 1888, Cooke noted that prairie chickens occupied the entire length of eastern South Dakota in a strip 30 to 60 miles (48–96 km) wide and were as far north as southeastern Corson county, as far southwest as southern Bennett county, and as far northwest as southwestern Harding county (Cooke 1888, Whitney et al. 1978). The historical distribution of the prairie chicken in South Dakota is shown by Aldrich and Duvall (1955).

Prairie chickens declined in the eastern third (tallgrass and tallgrass/midgrass transition prairies) of the state with intensive grazing of rangeland and conversion of grassland to cropland. Prairie chickens were gone from some areas of eastern South Dakota by 1920 and other areas by the early 1950s, (W.C. Foss, personal communication; L.M. Kirsch, personal communication). Some large wintering flocks of prairie chickens still occurred in Brown (including Sand Lake National Wildlife

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Refuge [SLNWR], Renziehausen Slough, Putney Slough and the James River) and Marshall counties in the early 1950s (L.M. Kirsch, personal communication). Three birds were sighted at SLNWR in 1982 (S. Waldstein, personal communication) and we assume these birds came from North Dakota, or at least from the north.

The earliest statewide population estimate for South Dakota was 80,000 prairie chickens in 1968 when the range was restricted to the central and south central portion of the state (Christisen 1969). By 1982, the statewide population had declined to about 39,000, the range was estimated at 9,171 square miles (23,750 km^2), and the average population density was 4.3 birds/square mile (1.7/km^2) (Fig. 1) (SDDGFP 1982).

In the mid-1980s, the Conservation Reserve Program (CRP) began with significant sign-ups in the main range in South Dakota and prairie chickens appeared to respond positively. While males per lek numbers compared favorably with those from the 1950s to the early 1970s, the number of males per square mile was a bit higher because of the increase in lek numbers. We also noted some expansion of the prairie chicken range to the east and north during that period. With the ending of many CRP contracts, we expect prairie chicken numbers to decline along with the amount of undisturbed habitat.

Yearly trend information for prairie chickens is presented from 1956 to 1997 (Table 1). The 42-year mean was 0.67 males per square mile. Peak years of prairie chicken populations coinciding with those of sharp-tailed grouse occurred in 1959, 1964, 1969, and 1980.

We believe that excellent reproduction for prairie chicken, as well as sharptails (West

Figure 1. South Dakota wildlife management regions showing distribution and relative density of greater prairie chickens, 1982.

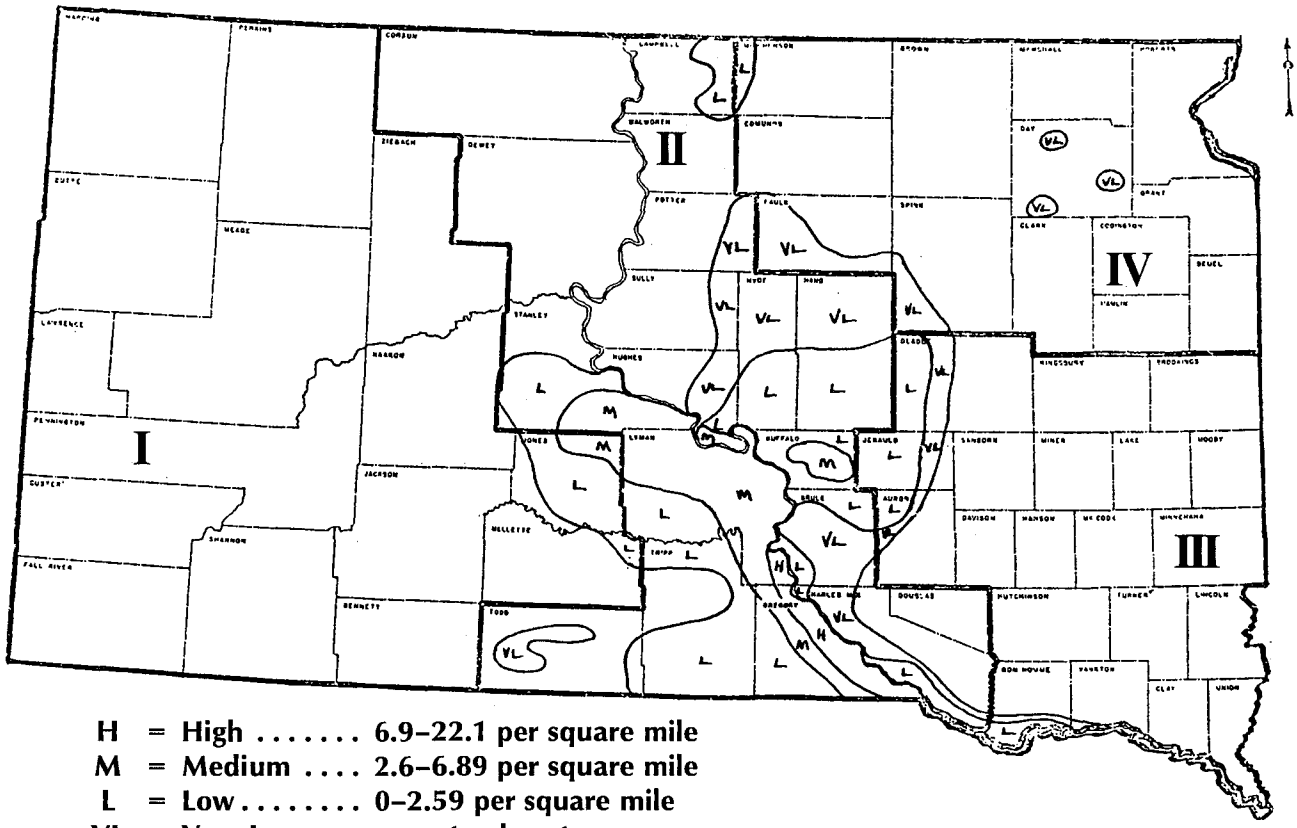

Table 1. Prairie chicken counts in South Dakota, 1957-97.

Year	Square miles	Males per lek	Males per sq. mile
1956	200	7.74	1.20
1957	200	6.29	0.98
1958	200	6.16	0.77
1959	200	9.18	1.29
1960	200	5.45	0.60
1961	160	7.40	0.46
1962	160	6.00	0.45
1963	185	4.52	0.74
1964	185	4.78	0.95
1965	185	4.27	0.72
1966	145	4.84	0.83
1967	185	4.42	0.76
1968	185	4.82	0.57
1969	185	5.85	0.63
1970	185	5.53	0.57
1971	185	5.90	0.48
1972	185	7.62	0.50
1973	185	10.58	0.69
1974	185	9.67	0.63
1975	175	9.00	0.93
1976	175	5.45	0.34
1977	175	4.90	0.29
1978	175	6.25	0.43
1979	175	8.14	0.98
1980	175	9.00	1.08
1981	175	7.80	0.85
1982	175	7.15	0.53
1983	175	7.00	0.48
1984	175	5.57	0.45
1985	175	6.33	0.54
1986	175	7.38	0.50
1987	175	8.00	0.80
1988	175	7.11	0.77
1989	175	5.36	0.43
1990	181	5.21	0.49
1991	181	4.19	0.51
1992	181	6.71	0.53
1993	181	7.65	0.66
1994	181	6.19	0.87
1995	181	9.07	0.62
1996	181	6.87	0.85
1997	181	5.73	0.59
Mean		7.02	0.67

1960) is related to cool moist summer weather because wet conditions in the spring and summer cause increased growth of grasses and forbs for better nesting and brood cover with a resultant higher survival of young. The lowest population was in 1977, after the severe drought of 1976.

Three research studies have been conducted on prairie chickens in South Dakota. Renhowe (1968) studied food habits and Rice and Carter (1982) evaluated grassland management practices as they affected prairie chicken populations on the Fort Pierre National Grasslands (FPNG). A radio telemetry study was conducted on the FPNG and on the Lower Brule Indian Reservation from 1985 to 1989 and included an evaluation of translocating birds to McPherson County in north central South Dakota (Fredrickson 1995, Fredrickson 1996). It is believed this transplant was unsuccessful because of the lack of cropland in the release area, made up primarily of ungrazed grassland. When birds moved to cropland areas in the winter, there was inadequate roosting cover and predation was so great that most did not make it back to leks in the release area the next spring. Future release areas should have at least 4 square miles (10.24 km^2) of quality grassland habitat intermixed with unharvested food plots of corn, sunflowers, and sorgum for high energy winter food.

A total of 75 greater prairie chickens were released at SLNWR in 1959 (15 males, 2 females) and 1960 (19 males, 36 females). The birds were trapped in the vicinity of Fort Randall Dam with cannon nets during the winter. Chickens were seen in the release area until March of each release year, but no booming grounds were established and the releases were considered unsuccessful (Kruse 1973).

Census and Survey Procedures

Since 1956, spring lek counts have been conducted to obtain an index of both sharp-tailed grouse and greater prairie chickens. The spring grouse survey consists of searching for

and counting males on leks along survey routes distributed throughout the grouse range. Each route covers approximately 40 square miles (104 km^2). Presently there are 27 routes censused each spring during April. Beginning in 1999, the number of spring routes will be reduced to 25 while the remainder of the survey will be the same. The spring survey represents our best index of the statewide prairie chicken population.

A randomized recording of observed broods of prairie chickens and sharp-tailed grouse is used to measure the reproductive success of both species. All personnel stationed in areas of the grouse range recorded all observations of prairie grouse broods. Personnel were encouraged to search for broods during early morning and late evening throughout the months of July and August. Beginning in 1998, we dropped the brood survey because of declining brood observations in recent years. Changes in field personnel, time constraints, and other duties made getting sufficient sample sizes difficult.

The prairie grouse bag check survey consists of collecting grouse data from hunter-bagged birds. Both road check stations and field checks were previously utilized to obtain the most possible data on young/adult ratios, sex ratios, and species composition of the harvest. The field check information is collected during the first 3 days of the hunting season. In 1998, the South Dakota Department of Game, Fish, and Parks (SDDGFP) plans to develop a wing mailing census for prairie grouse harvest data collection since field checks have proven insufficient for obtaining adequate information.

Harvest and Hunting Pressure

The harvest of prairie grouse in South Dakota has varied widely over the years. The lowest harvest on record was approximately 64,300 in 1977 while the highest was 174,300 in 1979. Hunting pressure over the years has remained fairly steady at approximately 20–25,000 hunters annually. Prairie chickens have accounted for approximately 5–8 percent of the annual prairie grouse harvest which has averaged approximately 80,000 birds. In recent years, there has been a decline in hunting pressure which may be explained by high travel costs and high pheasant populations in South Dakota. Harvest in the late 1980s to the early 1990s leveled off at lower numbers than in the previous decade, hence, harvest also declined with hunting pressure. Renewed interest and much better hunting opportunities in the mid-90s increased the statewide harvest. In 1996, the estimated prairie grouse harvest in South Dakota was over 109,000 with about 10% of that being prairie chickens.

Recent population estimates would indicate that the annual hunter harvest of both species is approximately 15 to 30% of the fall populations. Hunter harvest could expand upward without significant harm to the residual populations of either species under present conditions. Increasing interest in grouse hunting continues as a priority goal of the SDDGFP.

Species Needs

The most important need of prairie chickens is protection of rangeland, roadside cover, shoreline vegetation around stock dams, and woody draws from heavy cattle use (Rice and Carter 1982). Heavy grazing and trampling removes nesting, brood-rearing, escape, and winter cover. Research by Rice and Carter (1982) on the FPNG proved that rest-rotation grazing was superior to deferred rotation in providing nesting and brood-rearing cover for both prairie chickens and sharp-tailed grouse. An attempt should be made to encourage West River Region ranchers and public land managers to implement more rest-rotation grazing systems.

Conversion of grassland to cropland causes important losses of grouse habitat (Hillman and Jackson 1973). This practice should be discontinued and the converted ranges reseeded to native grasses. Protecting dense nesting cover similar to that in the Pheasant Restoration Program and the CRP would be beneficial to prairie chickens as would fencing out woody draws.

Public Needs

All state and federal lands with prairie chickens should be demonstration areas of good prairie chicken management. Interpretive signs which inform the public of the bird's presence should be erected on the FPNG and on state areas with significant populations of these birds. Increased population information should be more widely available to the public.

Management Needs

Additional funds are needed to pay West River Region landowners to establish dense nesting cover, food plots, and establish rest-rotation grazing systems for prairie chickens as well as pheasants. This was part of the CRP that appeared to be a positive influence on populations and, unless a replacement program arises, this will be a future need.

We need information on how to discourage conversion of grassland to cropland and how to best seed croplands to native grasses.

Information is needed on how to encourage moderate to light livestock grazing and develop incentives to fence out portions of woody draws and stock dams on private lands. Grazing or mowing of roadside cover should be discouraged. Consideration should be given to buying land to manage specifically for prairie chickens.

Research Needs

More research is needed to corroborate the 1988 preliminary findings (Fredrickson 1996) regarding the tendency of prairie chicken hens to select for taller cover for nesting and shorter cover for night roosting. Vegetation at nest sites should be determined at the time of nest initiation but measurements should be taken when radioed hens are well away from nests to reduce nest abandonment.

Research on habitat use is needed throughout the range of the prairie chicken. We need to better understand the influence of juxtaposition of quantity, quality, and shape of cover, food, nesting cover, brood habitat, roosting cover, and woody draws on population densities. We also need to determine the minimum quantities and quality of various cover types needed to sustain huntable populations in an area. We need more information on prairie chicken population dynamics and influence of predators on survival of young.

Better methods are needed to census prairie chickens on leks in April and to conduct brood counts during the summer.

We need to know if minimum habitat requirements given in the literature for release sites are correct for our state. Also, what minimum amounts of cover do prairie chickens need and use in areas where they now occur in low numbers?

We need additional research on summer to fall-winter, and winter to spring, movements of prairie chickens. We should document where known breeding populations spend the winter and where some known winter populations of birds display and nest. Of particular interest are the prairie chicken populations in Stanley, Lyman and Jones counties (FPNG), and in Gregory County.

Information is needed on whether we can better manage and increase populations by providing needed cover types on or near game production areas.

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Status and Management of the Greater Prairie Chicken in Nebraska

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Historical Review

The greater prairie chicken (*Tympanuchus cupido pinnatus*) has been a part of Nebraska's heritage for over a 100 years and remains a major component of the avifauna. Numbers have fluctuated over the years, reaching peak levels during the late 1800s only to plummet to extremely low levels during "The Great Depression" years of the 1930s. Prairie chicken numbers were so low that biologists and historians alike felt they would follow the path of the heath hen (*Tympanuchus cupido cupido*) and passenger pigeon (*Ectopistes migratorius*) to extinction. However, prairie chickens have rebounded from this seemingly doomed fate to huntable populations today and are cherished as a prized game species.

A close relative of the prairie chicken, the plains sharp-tailed grouse (*Tympanuchus phasianellus jamesii*), also occurs in the state and resides primarily in the western remote Sandhills region of north-central Nebraska. Historical accounts do not clearly distinguish between prairie chickens and sharptails, but greater emphasis appeared to be placed on prairie chicken ecology rather than sharptail ecology.

During the 1700s, little activity by European settlers and explorers occurred in this region of the Midwest and written accounts of prairie chickens or other birds of Nebraska are not available from early pioneers. French fur-traders and trappers were venturing up the Missouri River about 1700, but the first white men to reach Nebraska were Spanish soldiers around 1720 (Nebr. Legislative Counc. 1981). The Mallet brothers discovered and named the Platte River in 1739 and traveled nearly the entire length of the state on a journey from the Missouri River to Santa Fe, New Mexico.

The prairie chicken population began to blossom and expand during the latter portion of the 1800s, with low numbers reported during the first half century by early explorers. The first explorers to mention bird life were Lewis and Clark during their 1804–06 expedition up the Missouri River (Swenk 1935). Some species encountered were the white pelican (*Pelecanus erythrorhynchos*), American white egret (*Casmerodius albus egretta*), Canada goose (*Branta canadensis canadensis*) wood duck (*Aix sponsa*), eastern wild turkey (*Meleagris gallopavo silvestris*), interior least tern (*Sterna antillarum antillarum*), and interior Carolina paroquet (*Conuropsis carolinensis ludovicionus*). Captain Clark stated that on 2 September 1806 he saw 4 "prairie fowls common to the Illinois, those are the highest up which I have seen" either in Cedar County, Nebraska, or across the river in South Dakota (Swenk 1935). Zebulon Pike spent time in the

Republican River Valley in 1806 and Stephen Long traveled the Platte River in 1819, but neither mentioned anything concerning Nebraska's bird life.

Nebraska became part of the unorganized region, referred to as "Indian country" in 1821, followed by a period of overland trails beginning in 1832, with little mention of prairie chickens. Wagon trains loaded with merchandise forged along the state's first major trail, the "Oregon Trail," which followed the Little Blue and Platte rivers westward. Parkman (1922) tells about crossing eastern Kansas in 1846, coming up the Blue River into southeastern Nebraska and says "not even a prairie hen is to be had," but 4 years later when he came down the Arkansas River east of Cow Creek, plenty of prairie chickens were seen in the country of the Shawnees "where the maize stood high." These were Indian farming lands (Beck 1957). This party of voyagers carried shotguns and hunted often, as they mentioned the birds they killed and observed along the trail. They even killed a curlew (*Numenius americanus*), but not once did they kill a prairie chicken.

The Mormon Trail and Denver Trail traversed Nebraska prior to 1850, bringing thousands of wagons across the state every year. John C. Fremont explored the region in 1842 and was the first to use the word "Nebraska" in his publications. Prospectors crossed the plains of the Platte River valley en route to California seeking gold in 1849, a period often referred to as the "California Gold Rush." Through all these travels, little was mentioned concerning prairie chickens, thus it is reasonable to conclude that prior to 1850 few prairie chickens inhabited Nebraska.

Prairie chickens generated more notoriety beginning in 1854, but numbers were still apparently limited. Early newspapers spoke of how prairie chickens and other wild game were sold in hotels and other public eating places in Omaha and Nebraska City. These first settlements were established along the Missouri River and benefitted from the limited farming practices of the Pawnees, Ponca, Oto, and soldiers at Fort Atkinson. Small parcels of cropland were also beneficial to prairie chickens as their numbers increased, thus they initially became more numerous in Nebraska along the Missouri River.

Buechler and Barr (1920) convey in their memoirs, relating to the vicinity around Hall County, that when the first white settlers came to this portion of the Platte River Valley in 1857, buffaloes (*Bison bison*), elk (*Cervus canadensis*), wolves (*Canis lupus*), coyotes (*Canis latrans*), and badgers (*Taxidea taxus*) were plentiful, but turkeys (*Meleagris gallopavo*), deer (*Odocoileus spp.*) and prairie chickens were scarce. As these German settlers began to raise small fields of corn to sell at Fort Kearney, deer and prairie chicken populations began to grow, though the turkey soon disappeared. The old settler that observed the rise in the prairie chicken population related the increase to trapping of varmints and the end of prairie fires, but the settler did not take into account that better food and habitat was available for these species as well.

Beginning in 1860, the following 30 years marked dramatic changes for Nebraska and the prairie chicken population. Abraham Lincoln was elected president in 1860, the Civil War soon followed, Nebraska became a state in 1867, and the Union Pacific railroad was commencing construction in 1865, which was followed by construction of the Burlington and Northwestern railroads. The Free Homestead Law was enacted by Congress and took effect in 1863. The first large wave of settlement by homesteading immigrants began in 1867 and virtually the entire state was settled, except the Sandhills in north-central Nebraska, from 1875–90.

Homesteaders spread up every river valley, including the Platte, Elkhorn, Republican, Loup, Niobrara, and Blue rivers, and in most cases they were ahead of the railroads. Small crop farming followed the settlements and spread throughout the state. Prairie chicken populations exploded as these small crop fields were developed amidst the prairie and, by the latter portion of the 1860s, the birds inhabited all of eastern and southern Nebraska. The 1860s and 1870s thus produced the largest prairie chicken population on record

for Nebraska, and numbers have not attained that level since nor likely ever will.

Homesteaders were quick to capitalize on the overwhelming number of prairie chickens as they became a staple component of their diet. Initially, little was wasted and they harvested only what the family could consume because refrigeration was not yet available for long-term storage of many birds. These settlers also relied on geese, ducks, snipe, and other water birds as a part of their diet.

As soon as the railroads became established, the economic importance of the prairie chicken changed also, as eastern markets had created a demand for this species. Market hunting soon became the primary occupation of the region and chickens were harvested by the thousands. It was not practical for a market hunter to shoot and transport game more than 20 miles (32 km) from a railroad station. Even though many areas were not accessible to hunters, the harvest was still enormous.

Aughey (1878) noted that it was comparatively easy for a man with a trained dog to shoot from 50–200 chickens in a day in August, before the young were full grown and had become wary of man. Professor Aughey cited the following from the *Omaha Republican* newspaper dated 8 September 1865: "on the 6th, Captain Hoagland's party bagged 422 prairie chickens, 4 quails, 6 hawks, 1 duck, 4 snipe, and 1 rabbit; total, 462. Captain Kennedy's party bagged 287 prairie chickens, 2 quails, 8 hawks, 15 ducks, 6 snipe, and 1 rabbit; total, 353. Excluding the 2 rabbits, the total number for 1 day by these 2 parties was 813 birds." He also cited the *Omaha Herald* dated 10 September 1866: "A. Hoagland, esq., of Omaha, killed in 1 day 192 prairie chickens."

Not only was harvest tremendous on an individual or party basis, but regional and statewide figures were almost unbelievable. Aughey (1878) estimated that at least 300,000 prairie chickens were killed and shipped out of 30 eastern and southeastern Nebraska counties in 1874. A Lincoln dealer during the winter of 1875 shipped 19,000 prairie chickens to eastern cities, principally Boston and New York, during a 6-week period; approximately half of the shipment came from Lancaster County alone. A University Regent living in Tecumseh estimated from Johnson County that Tecumseh and Sterling shipped 6,500 and 3,500 chickens, respectively, during the winter of 1874–75. In addition to the 10,000 birds shipped, it could easily be assumed that at least 2,000 more birds were consumed in the county, as people generally survived on game that winter. A Pawnee City native estimated from the number of birds he knew were caught or shot that there must have been at least 20,000 prairie chickens harvested in 1874 in Pawnee County alone. Prairie chickens brought $4.00 per dozen from Chicago dealers, which indicates the economic importance of these birds to the people of the 1800s (Schildman and Miller 1956).

The massive exploitation of chickens by settlers and market hunters was stymied considerably during the mid-1870s by farmers, "ecologists," and the public. Survival of the prairie chicken was as economically important to the settlers as harvest. A devastating Rocky Mountain grasshopper invasion plagued the state in 1865 and continued through 1876. Prairie chickens, quail, blackbirds, and plovers proved beneficial to farmers due to their insectivorous habits and ability to consume approximately 150 locusts per day (Aughey 1878). When locusts invaded the Republican Valley in 1874, prairie chickens seemed to abandon all other foods. Little other than locusts was found in stomachs during a month (Aughey 1878), and Judd (1905) found that grasshoppers constituted greater than 90% of animal foods taken by prairie chickens.

Realizing the importance of this biological control agent, public sentiment in 1877 induced the legislature to make prairie chicken trapping illegal and ban their local sale and shipment to eastern markets. Due to the economic conditions of the period and lack of enforcement personnel, the law was basically ineffective and market hunting continued. During the late 1880s and early 1890s the state was marred by drought, which caused a further decline in the prairie chicken population. Market hunting was allowed once again

since many people needed to make a living when crop production was poor. However, the decline in prairie chickens and other game gradually forced out market hunters until they practically disappeared by 1920.

The 1900s marked a new era for prairie chickens: expansion to new ranges, reduction of the population to near extinction, temporary closure of hunting seasons, and recovery of the population to the self-sustaining huntable populations that currently exist. Three events were primarily responsible for these changes in prairie chicken numbers: the Kinkaid Act of 1904, World War I, and the drought of the middle 1930s.

Prior to the Kinkaid Act, the Sandhills were virtually untouched by settlement and remained an ocean of grassland. The Act allowed homesteaders to claim Sandhill acreage and within a short period almost every section of land was occupied by a family (Viehmeyer 1938). These farmers developed a patchwork of scattered fields in the meadows and river valleys of these expansive grasslands, which proved beneficial to prairie chickens. Where farm size averaged 608–1,215 acres (243–486 ha), chicken numbers were most abundant, because cultivated crops met winter food requirements and enough grassland remained to meet roosting, breeding, and nesting requirements (Mohler 1942). When more than a third of the natural grasslands were cultivated, prairie chicken numbers declined due to less desirable habitat conditions.

Along with the expansion in the chicken range came market hunters and the wholesale slaughter of birds. Hunters had basically a 365-day season, so it was inevitable that the species would be reduced from hundreds of thousands to only a small fraction of that number (Viehmeyer 1938). Also, automobiles, such as Ford models, became available around 1914 and made hunting for prairie chickens easier and faster with few areas of the Sandhills remaining inaccessible to the gun. By 1925, conditions had changed because area farms were too small to be self-supporting. Farms soon failed, land holdings were consolidated into fewer and larger ranches with significant reductions in cultivation, and prairie chicken numbers dwindled correspondingly.

The United States entered World War I in 1917 and Nebraska contributed greatly to the food supply (Nebraska Legislative Council 1981). The surplus food which supplied American soldiers and allies was produced in no small measure by Nebraska and surrounding states. This demand for grain brought the plow to much of the state's remaining grasslands outside the Sandhills, and even more of the prairie chicken range disappeared. By the mid-1920s, the number of prairie chickens in the state was perilously low and complete protection from hunting came in 1929.

Populations of prairie chickens and sharptails continued to decline during the 1930s, a period of drought often referred to as "The Great Depression" or "Dust Bowl" years. Following 1933, an influx of cattle came to the Sandhills from adjacent drought-stricken areas (Viehmeyer 1941). Ranges were stocked beyond their carrying capacity and vegetative cover was greatly reduced. Most nesting areas were denuded of cover, thus few birds were produced. Overgrazing continued until 1937 and prairie grouse populations fell to an all-time low due to the lack of suitable grassland habitat.

Mohler (1942) stated that the drought was "... an angel in disguise, ... a lifesaver to the prairie chicken by causing an adjustment in farming practices which restored many Sandhill border counties to good chicken habitat." Important features of this restoration were improved grazing and range management practices and consequent restoration of the grass, which coincided with the increase in farm sizes. With 1937 came the Soil Conservation Service and the Agricultural Adjustment Act that implemented rangeland improvement practices, such as deferred grazing, to the Sandhills (Viehmeyer 1941). Nesting cover soon became available on the range and prairie grouse populations began to rebound, saved from extinction.

During the fall of 1937 while canvasing Logan County, Viehmeyer (1941) observed 219 prairie chickens. Flocks were generally small, com-

posed of a dozen birds or less, with the only large flock (~125 birds) observed along the South Loup River, west of Stapleton. In the fall of 1940, flocks of 25–150 birds were common and an estimate of the total county population was 1,200 or more birds. This amounted to a 400% increase during the previous 3 breeding seasons (1938–40, inclusive).

In Holt, Rock, Brown, and Keya Paha counties, with 1,160 miles (1,931 km) of driving, 53 prairie chickens and 9 sharp-tailed grouse were counted in the spring of 1935 (Viehmeyer 1941). In the fall of 1940, approximately 1,500 prairie chickens and 1,000 sharp-tailed grouse were estimated in the same area. Comparison of spring and fall counts provides an unrealistic rate of increase, but consultation with local farmers, ranchers, and sportsmen throughout the area indicated that a 400–500% increase during the 6 breeding seasons was a reasonable estimate.

The geographic distribution of prairie chickens has changed fairly dramatically with time in Nebraska, but has stabilized and varied only slightly in recent years. Even though the species may have inhabited the entire state at one time (Fig. 1), its current range (Fig. 2) is associated with the Sandhills, particularly the eastern and southern edges, where grain crops have infiltrated the expansive grasslands (Johnsgard and Wood 1968). The greatest concentrations of prairie chickens occur in Holt, Rock, Garfield, and Wheeler counties, where rainfall averages 20.4 inches (51 cm) or more a year. Prairie chickens have penetrated the Sandhills, principally following the river systems as they progressed northwestward into the interior of the hills. Fair numbers of birds inhabit the grasslands of the southwestern portion of the state, as well as the southeastern counties along the Kansas border, which represent the northern limits of the large Flint Hills population (Johnsgard and Wood 1968).

The Sandhills region is considered the largest sand-dune area in the Western Hemisphere (Keech and Bentall 1971) and one of the largest grass- stabilized dune regions in the world (Bleed and Flowerday 1990). Situated in north-central Nebraska and extending a short distance into South Dakota (Fig. 3), the region covers approximately 20,000 square miles (4,9987 km^2), an area about 3 times the size of Massachusetts (Keech and Bentall 1971). Its east-west length is approximately 256 miles (426 km) and its north-south width about 125 miles (209 km). Dunes are created by prevailing winds and are generally oriented northwest-southeast, with the higher, steeper hills to the west and the smaller rolling hills in the east. Dunes are as high as 403 feet (122 m), as long as 19 miles (32 km), and slopes angling close to 25%. Deep, sandy upland soils

Figure 1. Approximate original and current distribution of the greater prairie chicken in North American (adapted from Johnsgard 1973).

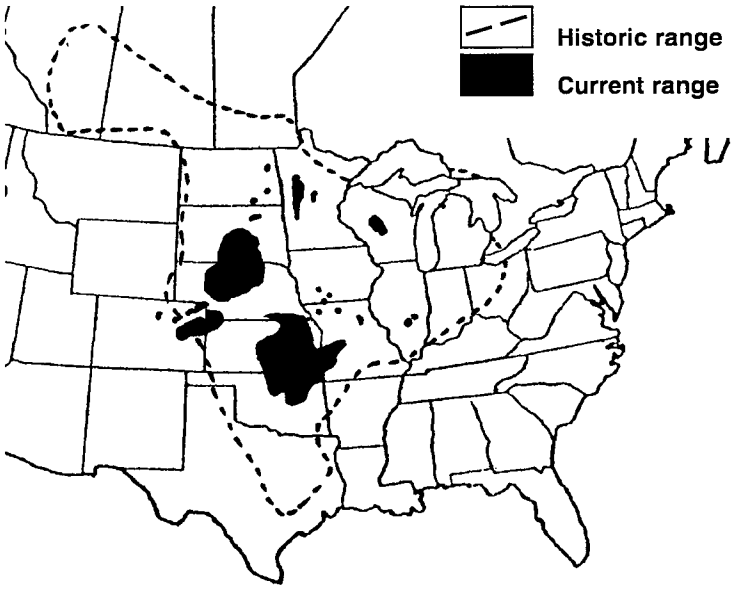


Figure 2. Current range of the greater prairie chicken in Nebraska.

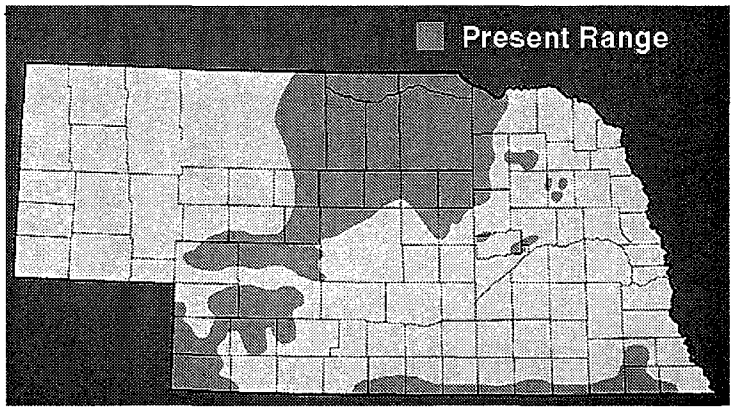
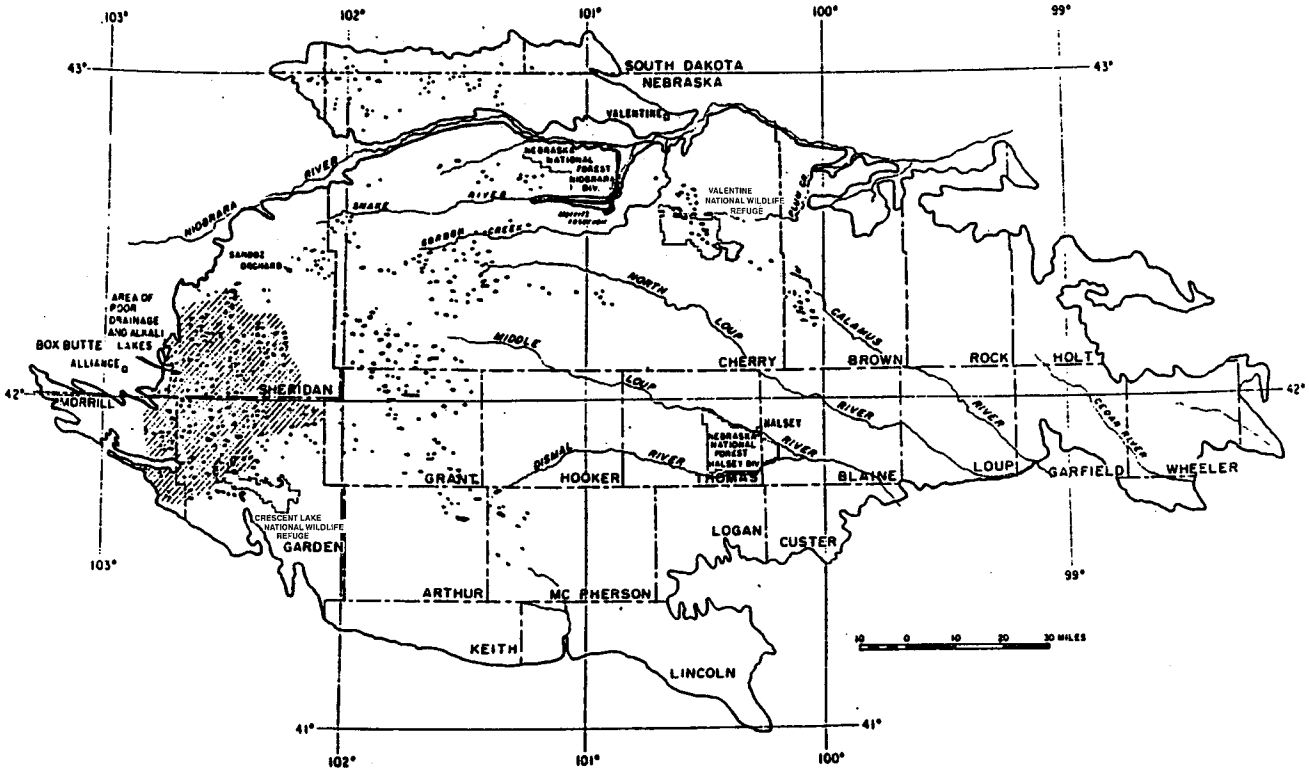


Figure 3. Extent of the Sandhills in Nebraska and South Dakota (Keech and Bentall 1971).



formed from wind-deposited sand are well drained and vary in texture from loamy fine sand to fine sand (Bose 1977). Valley soils however, are deep, relatively poorly drained, and vary in texture from loam to fine sand. The Sandhills possess 5 range sites which include wetlands, subirrigated, sandy, sands, and choppy sands range sites (Burzlaff 1962, Stubbendieck 1990). Average annual precipitation varies from 16–23 inches (41–58 cm).

Principal grass species occurring on sandy uplands are sand bluestem (*Andropogon hallii*), little bluestem (*Schizachyrium scoparium*), prairie sandreed (*Calamovilfa longifolia*), switchgrass (*Panicum virgatum*), sand lovegrass (*Eragrostis trichodes*), blue grama (*Bouteloua gracilis*), and needle-and-thread (*Stipa comata*). Bottomlands usually contain prairie cordgrass (*Spartina pectinata*), big bluestem (*Andropogon gerardii*), switchgrass, indiangrass (*Sorghastrum nutans*), little bluestem, reed grasses (*Calamagrostis spp.*), sedges (*Carex spp.*), rushes (*Juncus spp.*), and bulrushes (*Scirpus spp.*). Shrubs including lead plant (*Amorpha canescens*), inland ceanothus (*Ceanothus ovatus*), sunshine rose (*Rosa suffulta*), western sandcherry (*Prunus besseyi*), and small soapweed (*Yucca glauca*) occur along with miscellaneous forbs.

The Sandhills are well suited for livestock production, the main industry. Rangeland pasturing on the grassy dunes represents roughly 80% of the total land use (Miller 1990), followed by wild hay production (10%), planted or cultivated crops (5%), woodland (2%), and water (1%). The remaining 2% is farmsteads, ranchsteads, villages, small towns, roads and railways, and miscellaneous other uses. Ranches vary in size from 4,048–6,070 acres (1,619–2,428 ha) and utilize primarily cow/calf operations with stocking rates varying from 10–15 acres (4–6 ha) per animal unit per year in the eastern part of the region to about 30 acres (12 ha) per animal unit in the western part. Traditionally, pastures are grazed season-long, but in recent years the trend has

moved toward planned grazing systems, where several pastures are utilized on a rotational basis throughout the growing season.

Outside of the Sandhills, croplands are more prevalent and limit the distribution of prairie chickens. Cropland is important though as a winter food source and biologists suggest that populations are highest where 30% of the range is cultivated and 70% is native grassland (Farrar 1980). Smaller populations can be maintained on range consisting of 30–40% grassland, providing some of the grass is in large blocks.

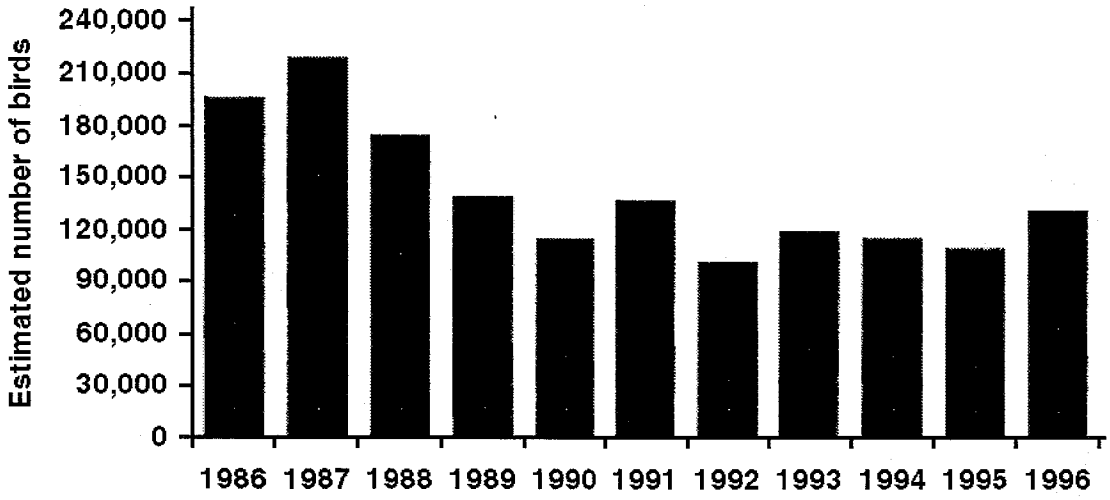
The prairie chicken range outside the Sandhills involves a larger percentage of cropland interspersed with rangeland and within counties, their distribution is associated with areas of more rangeland. In the southwest portion of the state, the landscape is composed of rolling sandhills, varying from 45–75% rangeland and 30–50% cropland, of which the main crop is irrigated corn. Progressing eastward, the sandy soils give way to predominantly loess and silt loam soils that range from 0–31% slopes. These counties generally lie along the Kansas border and vary from 37–43% rangeland and 53–60% cropland. Both dryland and irrigated farming are practiced where principal crops are corn, winter wheat, grain sorghum, and alfalfa. The southeast portion of the state contains a similar landscape with rolling hills, and steep hardwood draws. Grass species are similar to the Sandhills with big bluestem, switchgrass, indiangrass, and prairie cordgrass the dominant species.

The development of center-pivot irrigation created new economic opportunities for landowners in the Sandhills. Installation of irrigated cropland to supplement the ranching operation is also advantageous to wildlife populations by creating more edge and habitat diversity. However, excessive cropland development can have deleterious effects by reducing the quality of wildlife habitat. Conversion from grassland to cropland was more extensive and regionalized and had an adverse impact on the prairie chicken population since most of the conversion occurred in the eastern portion of the Sandhills. The hills were more gently sloping and more conducive to center-pivot systems. The 16 counties comprising the bulk of the Sandhills had about 64,500 acres (25,800 ha) of irrigated cropland in 1965 and by 1978 the total had risen to 535,000 acres (214,000 ha) (Nebraska Department of Agriculture 1980). Nearly 85% of the converted area was concentrated in the 9-county prairie chicken range (Blaine, Brown, Garfield, Holt, Logan, Loup, McPherson, Rock, and Wheeler).

Land use changes were documented on 10 spring display ground routes for comparison with changes in the prairie grouse population. In 1968, non-grassland habitat comprised 11% of the survey routes with a range of 1–33%, while in 1978, non-grassland habitat comprised 26% of the routes and ranged from 2–66% (Robertson 1980). Routes were divided to represent eastern, central, and western portions of the Sandhills. The percentages of total area consisting of non-grassland habitat increased with the eastern portion showing 43% non-grassland habitat in 1978 compared to 21% in 1968. The central portion increased to 20% non-grassland from 6% in 1968, while the western portion increased to 7% non-grassland from 2% in 1968. The average number of prairie grouse display grounds per route declined from 8.9 during 1967–69 to 7.0 during 1977–79 and males per ground steadily increased from 8.1 during 1967–69 to 8.9 during 1977–79. The increase in breeding males did not offset the general population decline. A noticeable change in the sharptail population was not detected. Major land use changes have not occurred in the Sandhills in recent years other than converting center pivot croplands back to grasslands through the Conservation Reserve Program (CRP) of the 1985 farm bill.

Population estimates are often difficult to devise for upland game bird populations, but the Sandhills lend themselves to projecting a realistic minimum estimate of the prairie chicken population. An estimate was derived by first determining square miles of prairie grouse range by county in the Sandhills. Range was then multiplied by a prairie grouse per square mile value derived by adding the males per square mile, obtained from 20-mile (32 km)

Figure 4. Estimated greater prairie chicken population in Nebraska, 1986-96.



spring display ground routes, plus females per square mile, plus production based on the subsequent fall juvenile per adult ratio in the harvest. The underlying assumptions for this value are that all males and display grounds were counted during peak activity, females were equally proportional to males in the spring, adult mortality was minimal prior to the breeding season, and production was similar across the entire prairie grouse range.

The annual prairie grouse cooperator survey was used to determine the proportion of prairie chickens or sharptails by county which, when applied to the total prairie grouse population, gave an estimate of prairie chickens by county. The same proportion of chickens by county was used for all years estimated. Summing all counties in the prairie grouse range provided a population estimate.

When comparing 1986 through 1996 estimates, the state-wide prairie chicken population reached its lowest level in 1992 with 102,325 birds (Fig. 4). The year 1987 provided the highest population with nearly 219,700 estimated birds and was probably one of the best populations in the past 25 years according to local accounts.

Population estimates for the southwest and southeast portions of the state are spurious because habitat is more fragmented and thus populations are often localized. A cursory examination has indicated their presence or absence within a county, but not densities.

Census Procedures

Each spring since 1955, the prairie chicken breeding population has been surveyed by conducting approximately 20 miles (32 km) of transect routes within the primary prairie grouse range. Currently, 13 routes are monitored with prairie chickens generally occuring on all but 3 routes. Surveys commence 1 April and it is recommended that all route work be completed prior to the last week of April, which corresponds to the peak of courtship activity. Each route requires a listening and locating portion be performed, with recommendations that listening runs occur 1–9 April and locating runs occur 10–20 April.

The listening portion begins 45 minutes before sunrise when wind velocity is 10 miles/hr (16 km/hr) or less. The observer ascertains the approximate location of active display grounds by listening at 1 mile (1.6 km) intervals for grouse booming and/or dancing activity. Display grounds are considered on transect and located if they are within 1 mile (1.6 km) of the transect route. Following the listening portion, display grounds either heard

or not heard but known to be active the previous 2 years are located and grouse present counted. Counts made with inactive birds and counts recorded >1 hour after sunrise are not considered during data analysis. Observers also estimate the number of grounds heard on transects but not located to determine total grounds on route.

Total birds on a ground are counted and a historical weekly percent males value is applied to the total birds present to derive an estimate of the number of males present. By definition, the number of males present is the ground size. Percent males values were derived from analysis of 20 years of "sexed" display ground data, and is used in ground size calculations to minimize time observing individual grounds. Thus, more grounds could be visited by observers. Only the maximum count for each ground is used for comparison with previous year's data. Once counts have been completed, display grounds are plotted on route maps that also convey other physical characteristics of the route. Grounds are assigned a number and each is dated for years that it was located.

Breeding populations in the Sandhills have fluctuated during the past 16 years (Table 1) with total males on transect and average number of males attending grounds peaking in 1988 and 1987, respectively. The prairie chicken population reached its lowest level during this period in 1982. Two reasons for the increase in prairie chickens could be the Conservation Reserve Program and the gradual movement westward of prairie chickens into the Sandhills, thus the species has become more prominent on routes that previously had few birds (e.g., Valentine National Wildlife Refuge).

Prairie grouse hunting seasons have been a part of Nebraska's heritage for over a century (Table 2). Obtaining all season dates prior to 1930 was difficult, but relatively liberal seasons were utilized. After an extensive period of season closure, the prairie grouse season was opened again in 1950 with a season held every year except 1954 with various bag and possession limits. The current policy of establishing season dates is to start the season on the Saturday closest to 15 September and end the last day of December. Figure 5 shows where hunting is currently permitted, in the

Table 1. Prairie chicken males and booming grounds recorded from 13 spring prairie grouse routes in Nebraska's Sandhills, 1982-97.

Year	Males [a]	Booming ground [b]	Males/ ground
1982	878.7	76	11.6
1983	1,006.1	95	10.6
1984	919.8	88	10.5
1985	1,060.4	94	11.3
1986	1,144.7	105	10.9
1987	1,387.9	114	12.2
1988	1,613.5	134	12.0
1989	1,383.1	129	10.7
1990	1,274.4	121	10.5
1991	1,061.1	103	10.3
1992	1,239.2	110	11.3
1993	895.9	97	[c]
1994	1,162.8	105	[c]
1995	1,496.0	129	[c]
1996	1,354.0	121	[c]
1997	1,087.0	109	[c]

[a] Male per ground value applied to grounds heard but not located per route and added to total males.

[b] Grounds heard but not located are included.

[c] Data not available.

Figure 5. Location of area open to prairie grouse hunting in Nebraska.

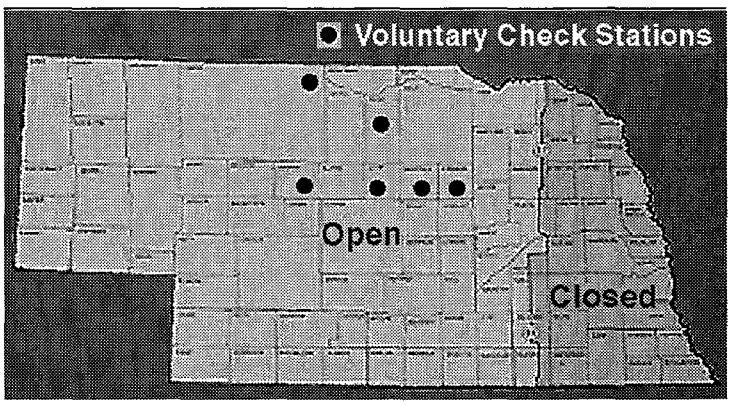


Table 2. Season dates, length (days), and bag and possession limits for sharp-tailed grouse hunting in Nebraska, 1890-1997.

Year	Season dates	Length	Bag limit	Possession limit
1890s	1 Sept. – 31 Dec.[a] (1 Oct.)	122 or 92	Unlimited	Unlimited
1901	1 Oct. – 30 Nov.	61	25	50
1905	15 Sept. – 28 Feb.	182	25[b]	50
1907	15 Sept. – 30 Nov.	76	25[b]	50
1909	1 Oct. – 30 Nov.	61	25	50
1911	1 Sept. – 30 Nov.	91	10	10
1912	1 Sept. – 30 Nov.	91	10	10
1913	1 Sept. – 30 Nov.	91	10	10
1914	1 Sept. – 30 Nov.	91	10	10
1915	1 Sept. – 30 Nov.	91	10	10
1916	1 Sept. – 30 Nov.	91	10	10
1917	15 Sept. – 14 Nov.	61	10	10
1920	15 Oct. – 14 Nov.	31	10	10
1921	1 Oct. – 31 Oct.	31	10	10
1922	1 Oct. – 31 Oct.	31	10	10
1923	1 Oct. – 31 Oct.	31	10	10
1924	1 Oct. – 31 Oct.	31	10	10
1925	1 Oct. – 31 Oct.	31	10	10
1926	1 Oct. – 31 Oct.	31	10	10
1927	1 Oct. – 31 Oct.	31	5	5
1928	1 Oct. – 31 Oct.	31	5	5
1930-1949	Closed			
1950	10 Nov. – 12 Nov.	3	2	2
1951	10 Nov. – 12 Nov.	3	2	2
1952	11 Oct. – 15 Oct.	5	3	3
1953	10 Oct. – 15 Oct.	6	3	3
1954	Closed			
1955	22 Oct. – 26 Oct.	5	2	2
1956	13 Oct. – 21 Oct.	9	2	4
1957	5 Oct. – 13 Oct.	9	2	4
1958	1 Oct. – 12 Oct.	12	2	4
1959	3 Oct. – 18 Oct.	16	4	8
1960	1 Oct. – 15 Oct.	15	3	6
1961	7 Oct. – 29 Oct.	23	2	4
1962	6 Oct. – 28 Oct.	23	2	4
1963	5 Oct. – 31 Oct.(North)	27	2	4

area of Nebraska west of US Highway 81. Boundaries of areas open to prairie chicken hunting have changed through the years.

Opening weekend courtesy roadside check stations, a grouse hunter cooperator survey, and a hunter report card survey are used annually to collect information on hunter harvest and success, distribution of harvest, and species, sex, and age ratios of prairie grouse.

Courtesy roadside check stations are generally operated annually near the following towns in Nebraska: Bassett, Burwell, Ericson, Halsey at the Bessey Division of Nebraska National Forest, Taylor, and Valentine. Biologists collect harvest and biological information on Saturday and Sunday of the opening weekend from 1000 hours to dark. Mandatory road checks, conducted by law enforcement personnel, are randomly used along major highways to stop all traffic and search all vehicles suspected of participating in hunting activities. One or 2 road checks are manned annually and provide some additional harvest and biological data.

The grouse hunter cooperator survey entails mailing wing questionnaire envelopes to avid prairie grouse hunters. Each hunter is assigned a number and asked to use 1 envelope per hunting trip and deposit a wing tip containing the outer primaries from each bird harvested, and to record date, hours hunted, and county hunted, along with number of birds bagged. Voluntary wing envelope boxes were placed at Bessey Division of Nebraska National Forest, Crescent Lake National Wildlife Refuge, McKelvie National Forest, and Valentine National Wildlife Refuge. Hunters were asked to respond to questions on wing envelopes, deposit a wing from each bird bagged in the envelope, and return envelopes to the boxes as they leave the area.

The hunter report card survey is used to obtain information pertaining to the success of resident upland game hunters throughout the state. The mailing list for the survey questionnaire was obtained from a random 5% sample of residents who purchased small game hunting permits during the preceding season. The calculation of total harvest represents a simple

projection of harvest reported by respondents to resident permit buyers. This survey does not include harvest by non-residents or those residents not required to buy a permit.

Harvest and Hunting Pressure

Harvest statistics of prairie grouse are not available for years prior to 1952, since no game surveys were conducted and only general accounts of the populations and harvest were made. Also, harvest was rarely separated by species, thus the proportion of sharptails to prairie chickens could not be known, but based on historical accounts it is believed prairie chickens represented the bulk of the harvest.

During the past 45 years, hunters and harvest have varied according to the status of the prairie grouse population (Table 3). The greatest harvest occurred in 1979 while the lowest harvest occurred in 1957. During the past 10 years, approximately 16,060 hunters pursued prairie grouse annually and harvested approximately 73,650 birds. Each hunter averaged 3.7 days afield during the season, bagged 4.2 birds a season, and usually retrieved 1.1 prairie grouse per day hunted.

The hunter report card survey gives a general account of hunters and harvest of prairie grouse during the past 45 years, but lacks sensitivity in evaluating success by hunters. This is most likely due to projecting success from a 5% sample of all hunters. The voluntary roadside check stations and cooperator wing envelope surveys attained similar success ratios.

Hunters annually bagged an average of 1.34 prairie grouse per day hunted, 0.29 prairie grouse per hour hunted, and their grouse harvest consisted of about 44% prairie chickens based on results from voluntary roadside check stations (Table 4). Poor success achieved in 1985 was primarily due to rainy windy weather during the opening weekend rather than the status of the bird population.

Table 2 (continued).

Year	Season dates	Length	Bag limit	Possession limit
	26 Oct. – 31 Oct.(South)	6	2	4
1964	3 Oct. – 1 Nov.	30	3	6
1965	18 Sept. – 31 Oct.	44	2	6
1966	17 Sept. – 31 Oct.	45	2	6
1967	16 Sept. – 5 Nov.	51	3	6
1968	21 Sept. – 17 Nov.	58	3	9
1969	20 Sept. – 31 Oct.	42	2	4
1970	3 Oct. – 15 Nov.	44	2	6
1971	18 Sept. – 17 Oct.	30	2	6
1972	16 Sept. – 15 Oct.	30	2	6
1973	22 Sept. – 4 Nov.	44	3	6
1974	21 Sept. – 3 Nov.	44	3	6
1975	20 Sept. – 26 Oct.	37	3	6
1976	18 Sept. – 17 Oct.	30	2	4
1977	17 Sept. – 16 Oct.	30	2	6
1978	16 Sept. – 29 Oct.	44	2	6
1979	15 Sept. – 4 Nov.	51	3	9
1980	20 Sept. – 11 Nov.	53	3	9
1981	19 Sept. – 15 Nov.	58	3	9
1982	18 Sept. – 14 Nov.	58	3	9
1983	17 Sept. – 30 Nov.	75	3	9
1984	15 Sept. – 30 Nov.	77	3	9
1985	21 Sept. – 30 Nov.	71	3	9
1986	13 Sept. – 30 Nov.	79	3	9
1987	12 Sept. – 30 Nov.	80	3	9
1988	17 Sept. – 30 Nov.	75	3	9
1989	16 Sept. – 30 Nov.	76	3	9
1990	15 Sept. – 30 Nov.	77	3	9
1991	14 Sept. – 30 Nov.	78	3	9
1992	12 Sept. – 30 Nov.	80	3	9
1993	18 Sept. – 30 Nov.	74	3	9
1994	17 Sept. – 30 Nov.	75	3	9
1995	16 Sept. – 31 Dec.	107	3	9
1996	14 Sept. – 31 Dec.	109	3	12
1997	13 Sept. – 31 Dec.	110	3	12

[a] *Season opening date varied between 1 September and 1 October during these years.*

[b] *Daily bag limit restricted to 10 birds during 2 weeks in September.*

Table 3. Hunters, harvest, days hunted per hunter (Days/h), birds bagged per hunter during season (B/h), and birds bagged per day hunted (B/day) of sharp-tailed grouse and greater prairie chicken derived from Nebraska hunter report card survey, 1952-96.

Year	Hunters	Days	Harvest	Days/h	B/h	B/day
1952	12,955	22,955	45,083	1.77	3.48	1.96
1953	No survey conducted					
1954	No survey conducted					
1955	7,057	11,715	15,313	1.66	2.17	1.31
1956	7,170	12,260	14,015	1.71	1.95	1.14
1957	7,010	10,445	8,538	1.49	1.22	0.82
1958	11,106	26,654	44,090	2.40	3.97	1.65
1959	18,000	41,040	73,100	2.28	4.06	1.78
1960	18,600	39,990	52,600	2.15	2.83	1.32
1961	17,000	42,500	53,700	2.50	3.16	1.26
1962	17,000	42,500	45,300	2.50	2.66	1.07
1963	20,700	89,010	56,000	4.30	2.71	0.63
1964	19,400	56,260	87,200	2.90	4.49	1.55
1965	16,500	47,850	53,000	2.90	3.21	1.11
1966	16,100	43,470	48,600	2.70	3.02	1.12
1967	16,200	55,566	61,600	3.43	3.80	1.11
1968	18,300	62,403	81,200	3.41	4.44	1.30
1969	17,500	53,100	47,200	3.03	2.70	0.89
1970	13,800	42,642	46,800	3.09	3.39	1.10
1971	15,500	44,950	48,100	2.90	3.10	1.07
1972	18,600	55,800	73,300	3.00	3.94	1.31
1973	20,800	64,480	78,500	3.10	3.77	1.22
1974	20,900	68,970	77,560	3.30	3.71	1.12
1975	13,870	38,836	45,910	2.80	3.31	1.18
1976	14,090	42,270	47,030	3.00	3.34	1.11
1977	13,190	43,527	51,440	3.30	3.90	1.18
1978	20,770	78,965	116,126	3.80	5.59	1.47
1979	21,694	84,184	116,303	3.88	5.36	1.38
1980	21,701	83,004	112,461	3.82	5.18	1.35
1981	20,520	76,381	97,804	3.72	4.77	1.28
1982	21,901	89,995	102,369	4.11	4.67	1.14
1983	No survey conducted					
1984	No survey conducted					
1985	21,300	75,391	76,898	3.54	3.61	1.02
1986	18,587	70,667	76,809	3.80	4.13	1.09
1987	20,195	75,007	98,875	3.71	4.90	1.32
1988	19,228	67,813	82,633	3.53	4.30	1.22
1989	18,549	60,237	71,345	3.25	3.85	1.18
1990	15,805	52,163	58,679	3.30	3.71	1.12
1991	17,205	61,896	69,229	3.60	4.90	1.12
1992	14,341	52,311	47,207	3.70	3.30	0.90
1993*	13,065	44,981	38,847*	3.19	2.76	0.86
1994*	15,625	60,156	70,837*	3.85	4.59	1.23
1995*	13,259	54,362	58,014*	4.10	4.40	1.07
1996*	13,332	56,883	63,856*	4.30	4.80	1.12

**Estimated value since data sets have not been "officially" analyzed.*

The most rewarding opening weekend was in 1987 when hunters took nearly 2 birds per day, or about 0.5 birds per hour hunted. The least rewarding year for hunters was 1993 when 2 years of unusually cold, wet weather during the brood-rearing season reduced production.

Data from wing questionnaire envelopes suggested that prairie chickens comprised 29% of the bag and cooperators averaged 1.44 birds per day and 0.33 birds per hour hunted (Table 5). Once again, 1987 was the most successful year in recent times for prairie grouse hunters while 1993 was the poorest. The difference in proportion of prairie chickens between voluntary check stations and cooperators is explained primarily by differences in the geographic distribution of check stations versus cooperators.

Age ratios of prairie chickens averaged slightly lower from wings submitted by cooperators throughout the season compared to the opening weekend (Table 6). Prairie chickens averaged 1.77 juveniles per adult from cooperator wings compared to 1.95 juveniles per adult during the opening weekend.

Table 4. Harvest, percent prairie chicken, birds bagged per day hunted (B/day), and birds bagged per hour hunted (B/hr) of prairie grouse sampled at 6 voluntary roadside check stations in Nebraska, 1982-97.

Year	Hunters	Harvest[a]	% Prairie chicken	Hunter success	
				B/day	B/hr
1982	723	1,392	41	1.39	0.29
1983	750	1,725	48	1.53	0.31
1984	630	1,408	40	1.56	0.31
1985	618	632	43	0.75	0.16
1986	408	921	49	1.71	0.34
1987	611	1,788	36	1.98	0.41
1988	640	1,281	50	1.36	0.29
1989	626	1,319	43	1.48	0.35
1990	577	1,158	55	1.34	0.28
1991	645	1,496	44	1.50	0.32
1992	559	956	39	1.10	0.22
1993	484	600	36	0.80	0.19
1994	909[b]	1,365	40	1.50	[c]
1995	942[b]	908	54	0.96	[c]
1996	723[b]	763	44	1.06	[c]
1997	704[b]	944	48	1.34	[c]

[a] *Plains sharp-tailed grouse and greater prairie chicken.*

[b] *Hunter days compared to hunters.*

[c] *Information not available.*

Species Needs

The habitat complexes available to prairie chickens in Nebraska are unique compared to other regions within their occupied range, primarily attributed to the unique topographic and spatial qualities of the Sandhills. Prairie chickens generally inhabit extensive areas of tall and mixed prairie grasses intermingled with cultivated fields, primarily corn, which is approximately 30% of the total area. Thus, prairie chickens are a species of the periphery of the Sandhills.

Range management practices generally dictate the seasonal suitability of Sandhills grasslands to prairie chickens. Nest site selection is based on the presence of dense, residual vegetative cover. Blus and Walker (1966) found the height of nesting cover varied from 3.8-9.2 inches (9.4-22.9 cm) with an average slightly over 5.1 inches (12.7 cm). Residual cover over 3.0 inches (7.6 cm) comprised 4.8-28.0% of the vegetation encountered during the pasture transects. Principal plant species forming nest canopies were sand lovegrass (*Eragrostis trichodes*), little bluestem (*Schizachyrium scoparium*) and prairie sandreed (*Calamovilfa longifolia*). Nearly all nests were located in pastures of excellent to good range condition, with 15.5% of the nests in prairies not used for 2 successive years. Many nests were located in prairies receiving moderate to full livestock use. Nesting cover is probably of lower quality in the major chicken range compared to the interior of the Sandhills primarily due to overgrazing and overmowing (Blus 1963).

Grassland conditions are also important during fall and winter. Loafing and roosting cover consisted of stands of mixed grasses. Stems

Table 5. Number of cooperators, harvest, percent prairie chicken, birds bagged per day hunted (B/day), and birds bagged per hour hunted (B/hr) of prairie grouse derived from cooperator wing questionnaire envelopes in Nebraska, 1983-96.

Year	Cooperators [a]	Harvest [b]	% Prairie chicken	Hunter success	
				B/day	B/hr
1983	81	2,215	13	1.47	0.37
1984	68	1,871	17	1.44	0.35
1985	57	1,483	19	1.38	0.32
1986	68	2,208	21	1.46	0.31
1987	68	3,266	25	1.74	0.41
1988	77	2,140	34	1.44	0.32
1989	70	1,609	32	1.49	0.31
1990	71	1,499	38	1.35	0.27
1991	68	1,931	34	1.59	0.37
1992	63	1,492	23	1.25	0.29
1993	68	1,167	30	1.16	0.28
1994	Not available				
1995	51	552	53	1.56	0.32
1996	53	453	42	1.43	0.39

[a] *Includes only participating cooperators and not their hunting companions.*

[b] *Plains sharp-tailed grouse and greater prairie chicken.*

over 24.4 inches (61.0 cm) in height were found to be 9 times more numerous on the area used by prairie chickens than were found on adjacent heavily grazed areas (Mohler 1952). Fairly dense cover extending from 12.2-24.4 inches (30.4-61.0 cm) was 5 times more prevalent in pastures used by the birds. Dense understory or litter layer of 8.6 inches (21.6 cm) or more in height was preferred as loafing and roosting areas. Heavily grazed pastures deficient of tall grass cover and inadequate understory were avoided by prairie chickens.

Home ranges during the fall generally did not exceed 0.7 miles (1.2 km) from the flushing point (Mohler 1952). The distance from night roosting sites to feeding areas varied from 0.1-0.7 miles (0.2-1.2 km). Presence of winter feeding areas near roosting areas appeared to be an important factor in determining whether an area will be occupied by prairie chickens, but a suitable food source alone will not ensure an area will be occupied. Adequate grassland cover must also be available.

Public Needs

The Sandhills are primarily under private ownership, thus hunting opportunities for prairie grouse are generally obtained by dealing with individual landowners. This is particularly true with hunting the major prairie chicken range. Access to private lands may be difficult during the opening 2 weekends of the prairie grouse season, but generally landowners are receptive to hunters.

Scattered state wildlife management areas exist within the region, but offer limited opportunity for harvesting prairie chickens. These areas are few in number and contain principally deer, turkey, waterfowl, and pheasant habitat rather than prairie grouse habitat. The only wildlife management area (WMA) that offers a reasonable opportunity for bagging a prairie chicken is the Calamus Reservoir WMA. State public hunting lands could be expanded by allowing public hunting on Board of Education lands. An access program to these school lands, which are leased to private individuals, would greatly enhance hunting opportunity.

Federal lands provide hunting opportunities in the Sandhills, but unfortunately are situated primarily in the sharp-tailed grouse range rather than the prairie chicken range. These federal lands (totaling 327,383 acres [130,953 ha]) consist of 2 national wildlife refuges (NWR) and 2 tracts administered by the U.S. Forest Service. Valentine NWR contains 72,353 acres (28,941 ha) of primarily grasslands interspersed with wetlands, on which approximately 15% of the prairie grouse harvest is prairie chickens. Bessey Division of the Nebraska National Forest contains 91,503 acres (36,601 ha) of primarily grasslands, on which approximately 20% of the prairie grouse harvest is prairie chickens. Crescent Lake NWR contains 46,535 acres (18,614 ha) of habitat similar to the Valentine NWR, and

McKelvie National Forest contains 116,993 acres (46,797 ha) of primarily grasslands with a small forested area. Primary harvest on both areas is sharptails.

Viewing blinds are placed on several of the federal lands to observe the spring courtship ritual of the prairie chicken. Prairie chicken blinds are located at Fort Niobrara NWR and Bessey Division of the Nebraska National Forest. School field trips, youth group activities, and adult education programs could enjoy a spectacular outdoor and cultural experience by visiting these early morning displays on the booming grounds.

Management Needs

Prairie chicken populations are a product of the environment they inhabit, thus the quality and quantity of habitat is important. Various successional stages of the plant community are desired to fulfill the life requirements of chickens, but the primary limiting factor in the Sandhills for growth in the population is secure nesting cover. Since ranching is the main industry of the region, range management for livestock production takes precedence over prairie grouse production. Maintaining a climax plant community in excellent range condition, desirable for nesting prairie chickens is not always accomplished when livestock production is the primary objective. Ranchers can generally attain higher sustained yields of livestock from range in excellent condition. Overstocking the range may contribute to long-term declines in range condition and productivity, which in turn reduces nesting cover and deteriorates shrubby cover utilized by broods.

Sisson (1975) provided several recommendations to optimize sharp-tailed grouse habitat in Nebraska which would also prove beneficial to prairie chickens:

1. *Limit annual utilization of forage to no more than 50% of new growth; reduce utilization if forage does not consist of at least 75% climax species until that composition is reached.*
2. *Use a deferred rotation with 2 pastures on a last out, first-in schedule. Maintain pastures of 1,295 acres (518 ha) or more with adequate water and salt distribution.*
3. *Regulate grazing to allow approximately 15% of each pasture grazed to remain unused each season.*
4. *Winter-graze pastures dominated by choppy sands sites when feasible.*
5. *Ensure adequate woody cover.*

Leonard McDaniel (U.S. Fish and Wildlife Service, personal communication) has been active with sharp-tailed grouse and prairie

Table 6. Juveniles per adult (juv/ad) and juveniles per adult female (juv/ad F) age ratios of prairie chicken obtained from voluntary roadside check stations and cooperator wing questionnaire envelopes in Nebraska, 1978-97.

	Voluntary check station			Wing cooperators	
Year	Sample	Juv/ad	Juv/ad F	Sample	Juv/ad
1978	175	4.00	5.60	324	2.95
1979	156	1.47	3.14	381	2.18
1980	174	1.46	3.92	449	1.52
1981	167	1.21	2.19	301	1.61
1982	225	1.84	3.20	[a]	[a]
1983	246	1.89	4.13	273	1.57
1984	166	2.25	4.42	301	1.77
1985	166	1.44	2.88	258	1.49
1986	294	2.61	4.74	443	2.68
1987	246	2.32	5.38	769	2.49
1988	208	1.36	2.22	692	1.40
1989	186	1.45	2.62	499	1.40
1990	164	1.25	1.90	531	1.21
1991	236	1.81	3.23	643	2.26
1992	145	1.27	2.19	332	0.98
1993	152	3.30	5.10	332	2.07
1994	478	2.57	[a]	[a]	[a]
1995	441	1.27	[a]	250	0.70
1996	275	1.81	[a]	191	1.17
1997	305	2.35	[a]	[b]	[b]

[a] *Data not available.*

[b] *Analysis not yet complete.*

chicken management since 1972, primarily evaluating grassland management practices for wildlife on the Valentine NWR. If grazing is the primary land management tool utilized, McDaniel recommends delaying grazing of undisturbed cover until after the nesting season, which corresponds to late June or early July. During the following spring, enter the last pasture grazed the preceding year first for a short duration generally through May. Rest the pasture for the remainder of the year and through the nesting season of the succeeding year. Maintaining this sequence incorporates rest periods for plant regrowth and ensures suitable nesting cover for prairie grouse.

Generally, several grazing strategies are available to manage for prairie grouse habitat. Maintenance of some cover in all pastures is desirable and can be accomplished through stocking rates, pasture size, period of grazing use, and distribution of livestock. Shrubs and other woody cover are utilized by broods and loafing adults, thus protection of these acres through fenced enclosures or minimal livestock use is desirable.

Hay meadows are considered ideal habitat for prairie chickens and are generally hayed for livestock production. It would be desirable to stop mowing after 1 August to allow sufficient regrowth for spring nesting. The ideal mowing period would be 1-15 July, but the alternative of 1 July-1 August would provide nesting habitat. Raising the mow bar would be another option to help maintain warm-season grasses. If meadows are grazed, chickens would benefit most by a spring graze followed by 2-3 years of rest.

Prescribed burning may be used as a management tool in the Sandhills, but with caution due to the fragile nature of the soils. Erosion could be a potential problem if adequate moisture to stimulate regrowth is not available. Fire is less of an erosion problem in meadows compared to upland sites.

Cropland, primarily that devoted to corn, adjacent to quality grasslands is desirable for winter feeding areas. Prairie chickens generally inhabit areas associated with cropland over areas without cropland. Cultivated areas should not exceed 30%.

Research Needs

The life histories of the prairie chicken and sharp-tailed grouse are much more difficult to understand and observe than most other upland game bird species. Their dependence on expanses of grasslands creates for them a content, solitary, remote existence. Understanding and assessing the intricate factors that affect their survival places constraints on evaluating fluctuations in the population. Prairie chickens thrive on the periphery of the Sandhills of Nebraska and provide many hours of recreational opportunity, yet many questions remain as to why they abound or decline.

Research should continue to address nesting requirements in the Sandhills. Intensive grassland management has affected many wildlife species including prairie chickens. Various planned grazing systems are being utilized in the Sandhills, thus addressing the positive or negative impacts on prairie chicken nesting success should be studied. How many pastures and how big? What sequence of livestock rotation? When should you graze? What stocking rates under various rotations should be utilized? Also, relative to nesting success, what role does nest fidelity play in prairie chicken ecology? What types of nesting habitat do juvenile females select versus adult females? At what spatial scale do hens select patches of cover?

A considerable amount of research should emphasize brood habitat and brood survival. A major obstacle confronting managers is forecasting pre-hunt population levels. Generally, spring booming ground routes provide reliable information concerning the breeding population, but cannot be used to project productivity and hence fall populations. The problem relates to obtaining estimates of production and brood survival. Research should therefore concentrate on climatic and physical factors affecting productivity (i.e. nest success and chick survival). Knowledge of these

relationships (if present) would help managers forecast regional fall population sizes without the benefit of reliable brood counts, which are often difficult to obtain.

Finally, past research has indicated that predators influence nesting success on sharptails. Coyotes appear to be the major nest predator, but relatively little is known about how predators affect survival and productivity of prairie chickens in the Sandhills.

Recommendations

It is recommended that the following ideas and proposals be pursued to expand existing knowledge of prairie chicken ecology in Nebraska:

1. Continue spring booming ground routes in the Sandhills and develop new routes in the primary prairie chicken range.

2. Further evaluate prairie chicken nesting ecology with emphasis on the suitability of habitat.

3. Evaluate how planned grazing systems affect prairie chicken populations and develop a grazing strategy which enhances chicken populations while maintaining the goals of individual ranching operations.

4. Determine brood habitat requirements and assess biotic and abiotic factors affecting nest success and brood survival.

5. Establish and evaluate brood routes or prairie chicken observation routes during the summer to develop an index of production which will help make projections of fall populations.

6. Continue all current surveys to monitor success of the fall hunting seasons.

7. Develop a model depicting prairie chicken ecology in the Sandhills.

8. Evaluate population levels and range expansion for prairie chickens outside the primary range.

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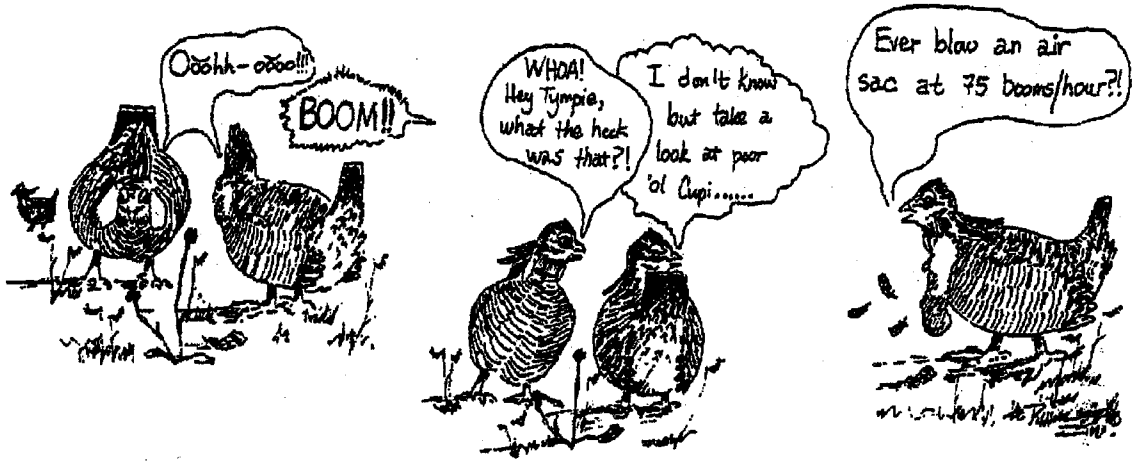

Population Status and Distribution of Greater Prairie Chickens in Colorado

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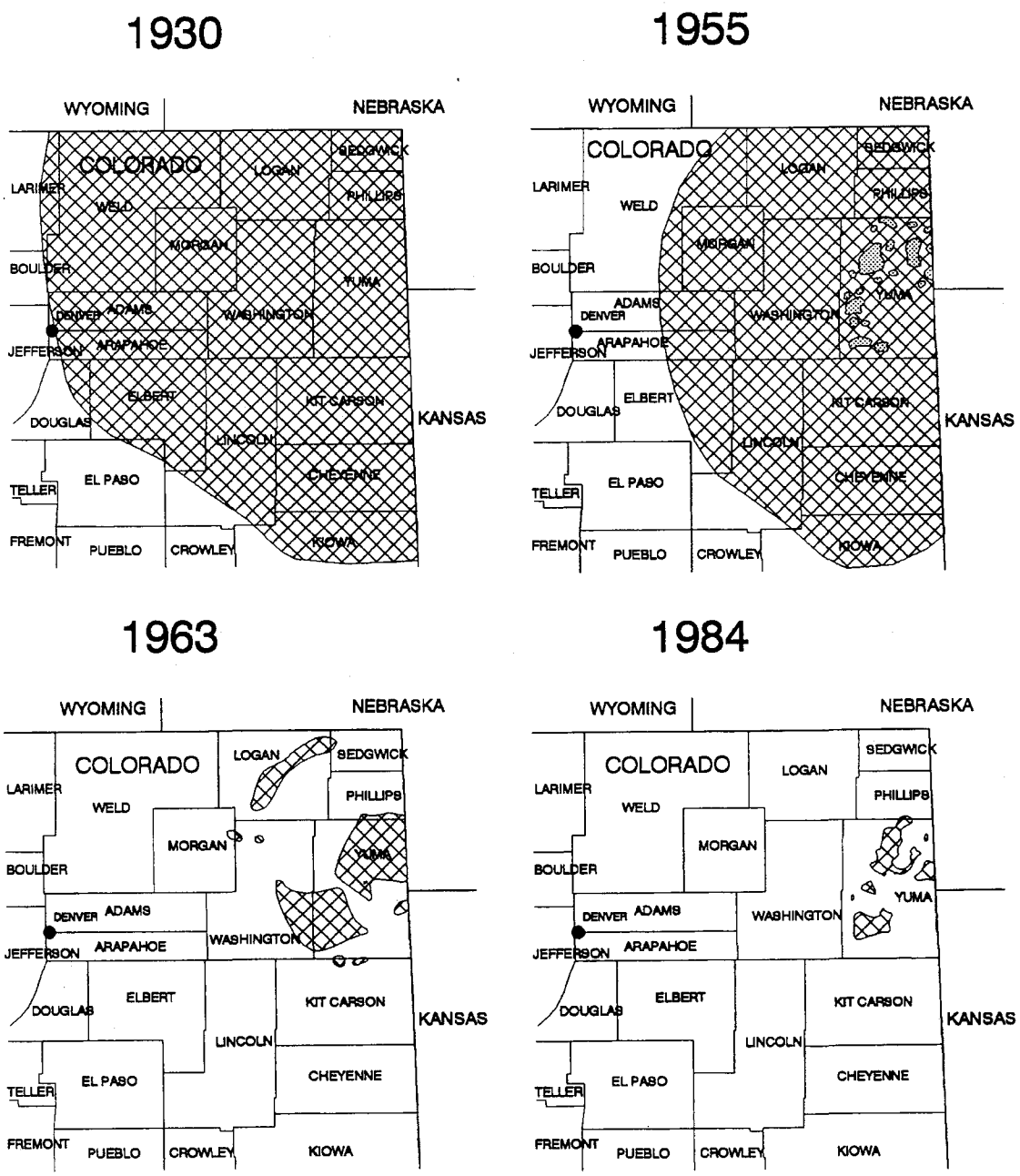
Historical Review

Greater prairie chickens (*Tympanuchus cupido pinnatus*), hereafter referred to as "prairie chickens," may have inhabited portions of 25 states and 4 Canadian provinces at their maximum distribution in North America following European settlement (Schroeder and Robb 1993). They may not have been native to Colorado, however, as Cooke (1897) did not record them, and later (Cooke, 1898) contended that habitats west of Ogallala, Neb., (about 25 miles [40 km] northeast of Colorado), were not suitable for prairie chickens. The first documented observation was reported in 1897 near the present location of Julesburg in Sedgwick County (Sclater 1912). By 1900, this species was reported as "not an uncommon breeder" (Cooke 1900) near Wray in Yuma County. There is evidence that prairie chickens responded positively to grain agriculture and markedly expanded their range westward into Colorado with settlement (Schorger 1944, Beck 1957, Christisen 1969, Horak 1985). The farthest westward documentation of prairie chickens in Colorado was in 1907 when a nest was found near Barr Lake in Adams County (Hersey and Rockwell 1909). Prairie chickens apparently occurred in at least 7 and perhaps 9–11 counties in northeastern Colorado (Fig. 1) from 1897 to the mid-1930s (Evans and Gilbert 1963, Christisen 1969, Van Sant and Braun 1990). This range is generally considered the maximum historical range of greater prairie chickens in Colorado (Aldrich and Duvall 1955).

Throughout the 1930s, prairie chicken populations and distribution declined in Colorado. The hunting season was closed initially in 1929–32 and permanently in 1937. This rapid population decline prompted a study to estimate the total number of prairie chickens in the state. Swope (1953), using winter flock counts in Yuma County, estimated a total population of 2,835 prairie chickens in Colorado. He repeated this census in the spring by counting birds on booming grounds and reported a similar estimate of 2000 prairie chickens. Using anecdotal evidence, Swope (1953) concluded that prairie chicken numbers had increased in Colorado between 1949 and 1952. However, he examined relatively few leks (n = 20) and assumed a male-biased sex ratio (1 male: 0.77 females) to estimate female numbers.

It is possible that from 1949 to 1952 the trend of increasing prairie chicken numbers repre-

Figure 1. Changes in distribution of greater prairie chickens in Colorado from 1930 to 1984.



sented recovery of the population after the dramatic decline during the 1930s. Aldrich and Duvall (1955) suggested that the 1955 range of prairie chickens was still large in Colorado, relative to the "historical" range. Even though Aldrich and Duvall (1955) likely overestimated Colorado prairie chicken habitat, their study, and surveys conducted by Swope (1953), indicated that the state population of prairie chickens was well over 2,000 in the early 1950s.

By 1963, the Colorado population of prairie chickens had reportedly declined to 700–800 (Evans 1964). Total population estimates for the 1963 census were extrapolated from ex-

amination of a small amount of Colorado's prairie chicken habitat (mostly the northern half of Yuma County). Also, the population estimate was based on the assumptions of 100% male lek attendance and detectability, and an equal sex ratio (booming ground counts rarely differentiated between males and females). Even so, the decline in both lek numbers (20 to 10) and the number of birds per lek (25 to 7), indicated the population likely decreased markedly between 1952 and 1963. In 1973, the population was still low, an estimated 600 birds, and the Colorado Wildlife Commission declared the prairie chicken an endangered species in Colorado (Graul 1975). The overall trend of declining populations and increasingly fragmented distribution since the 1930s (Fig. 1) resulted in the Colorado Division of Wildlife increasing research and management efforts on prairie chickens.

Recent Management and Reintroduction Programs

Beginning in 1978, upland portions of the Tamarack State Wildlife Area, along the North Platte drainage in Logan county, have been managed for prairie chickens through reseeding native warm-season grasses and prescribed burning (Hoffman 1985). Although the Tamarack prairie once may have comprised part of prairie chicken range as recently as 1963, sightings near this area prior to transplanting were infrequent and no booming grounds were located. A reintroduction of prairie chickens from Yuma County to the Tamarack State Wildlife Area was conducted in late March and early April of 1984 when 36 (20 females, 16 males) were released. An additional 40 birds (25 females, 15 males) birds were released at this site in 1985 (Hoffman 1985). A supplemental release of 24 prairie chickens (13 females, 11 males) occurred in April 1990. All released birds were banded and several were radio-marked to document movements, nest success, and survival. Following the transplants, about 40 booming grounds were located and in 1996-97 at least 18 booming grounds were active. This population of prairie chickens expanded its range from Sterling to Sedgwick south of the Platte River with 1998 population estimates exceeding 300 to 400 birds.

Additional transplants of prairie chickens in Colorado occurred during the early 1990s. Prairie chickens were trapped on booming grounds in Cowley County, Kansas, and transplanted to the Well's Ranch in western Weld County in April 1991 (23 females, 27 males) and April 1992 (27 females, 23 males) (Beauprez 1994). Additional birds (21 females, 20 males) were trapped in spring near Wray in Yuma County and released in the same general area in April 1993. Three booming grounds were located in 1991 and 1992 following the release, with a total of 16 and 14 males identified, respectively (Beauprez 1994). Despite the release of additional birds at this site in 1993, no additional booming grounds were located. Surveys conducted since 1994 found few birds suggesting that a population of prairie chickens did not become established at this site.

Another transplant of prairie chickens was conducted in 1991-92 when birds trapped on booming grounds in Yuma County were released in Washington County (Beauprez 1994). Forty-three birds (23 females, 20 males) were released in April 1991 and 41 birds (22 females, 19 males) were released in April 1992. Five booming grounds with 22 males were located following the 1991 release and 6 booming grounds (30 total males) were located in 1992 (Beauprez 1994). At least 8 active booming grounds were located in 1996-97 and this transplant appeared successful. Population estimates in 1998 for this population were 100 to 200 birds.

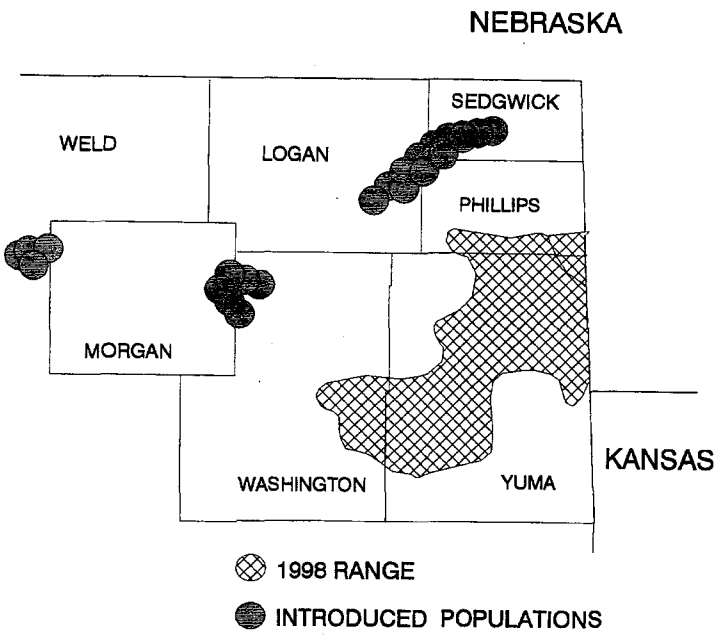
Current Population and Distribution

Prairie chickens presently occur in Yuma, Phillips, Washington, Logan, Sedgwick, Morgan, and Weld counties (Fig. 2). The core population in Yuma, Washington, and Phillips counties is currently estimated at 8,000 to 10,000 birds and is judged to be stable or increasing. The population resulting from the Tamarack transplant is estimated at 300 to 400 birds

and continues to expand its range. The more recent transplants have not markedly increased the overall populations in Colorado although the Washington County transplant appears successful.

Prairie chicken abundance and distribution are closely tied to land-use practices, and the conversion of some grain fields to warm-season grasses under the Conservation Reserve Program likely was partially responsible for the increasing populations and expanded range of the species in Colorado. While the stability of current farming and grazing programs and practices cannot be predicted with certainty, it is likely that prairie chicken populations in Colorado will exist at current levels in the short-term.

Figure 2. Current distribution of greater prairie chickens in Colorado.



Harvest and Hunting Pressure

Prairie chickens have not been legally hunted in Colorado since 1936. Their increasing populations and expanded distribution has resulted in recent efforts to change their status from state endangered (non-game) to a game species. While most hunters (88%) and non-hunters (71%) would support limited hunting of this species if the Colorado Division of Wildlife determined populations were large enough to accommodate a harvest (Braun et al. 1994), most landowners having populations of prairie chickens are not in favor of hunting at this time. In May 1998, the Wildlife Commission voted to remove the greater prairie chicken from the state list of threatened and endangered species and classify it as non-game wildlife. Until this species is reclassified as a game species, it may not be hunted in Colorado.

Species Needs

The history of prairie chickens has been closely tied to the agricultural practices of pioneer and present day farmers/ranchers (Beck 1956). Prairie chickens are almost entirely restricted to private lands in Colorado, and thus, their future is largely dependent upon private land management practices. Emphasis needs to be placed on the preservation and proper management of prairie chicken habitat in Colorado. Prairie chicken habitat in the state of Colorado is unique when compared with typical prairie chicken habitat in other parts of North America. For appropriate prairie chicken management in Colorado, additional research is needed on seasonal food habits and nutritional requirements, roosting cover, breeding, nesting, and brood habitat.

Additionally, special efforts need to be made to communicate habitat requirements of prairie chickens to private landowners. Generally, most landowners within prairie chicken range are interested in prairie chickens and view them with a source of pride and nostalgia. However, changes in land use practices are slow to take hold in difficult economic times and incentives may be needed to compensate private landowners and managers for implementing habitat management practices beneficial to prairie chickens.

Public Needs

There is increasing demand from the public (naturalists, bird-watchers, and/or photographers) to observe prairie chickens on booming grounds during spring. The Wray Museum in Yuma County sponsors 3-4 weekend public tours (including evening programs, access to an observation blind on private land, and breakfast) each spring and always sells out in advance. This popular project has support from landowners in the area as well as businesses in Wray.

Research and Management Needs

Understanding the ecology of prairie chickens in Colorado is critical for their management. Unfortunately, many basic questions about the prairie chicken's biology remain unanswered. Additional information on sex ratios, causes of mortality, factors affecting nest success, population fluctuations, dispersal, migration, and seasonal movements is needed to properly monitor populations and manage this species.

At the heart of prairie chicken management is the necessity for information on seasonal habitat requirements. Specifically, factors that limit both the range and population density of prairie chickens in Colorado require further study. Some habitats presently unoccupied by prairie chickens could potentially support chicken populations. Procedures for improving and/or restoring habitats for prairie chickens need to be evaluated and recommendations made available to wildlife managers and private landowners.

Management decisions are often based on population and/or density estimates, emphasizing the need for better techniques to estimate numbers of prairie chickens. A standardized and statistically valid census or population monitoring procedure should be implemented. Additionally, accurate information on sex ratios, lek attendance by males and females, movement between leks, movement between leks and nests, and metapopulation characteristics is essential for monitoring population levels.

Recommendations

Emphasis needs to be placed on research so management efforts are productive. Ideally, adaptive management strategies should be implemented, thereby building a foundation of data that will aid in understanding prairie chicken ecology. This approach was tried with some success when prairie chickens were transplanted to the Tamarack State Wildlife Area, and later to Weld and Washington counties.

Education of private landowners should be an important consideration in management programs for prairie chickens. Effective management strategies by landowners to benefit both their economic interests and wildlife should be encouraged. Access to leks should be managed to meet demands of watchable wildlife programs while minimizing disturbance of prairie chickens during the breeding season.

Summary

Prairie chickens apparently were not indigenous to Colorado but expanded into the northeastern corner of the state following settlement and conversion of some native grasslands to small grain agriculture in the late 1890s. Both distribution and populations of prairie chickens in Colorado peaked prior to the "Dust Bowl" days of the 1930s. Populations remained low into the 1960s and 1970s and resulted in the Colorado Division of Wildlife classifying this species as *state endangered*. Habitat and population management practices including burning of rangelands, seeding of native warm-season grasses, restoration of grasslands under the Conservation Reserve Program, and a series of transplants, resulted in increases in both distribution and populations of prairie chickens in Colorado.

Current prairie chicken populations are variously estimated to be between 8,000 and

10,000 birds and this species is no longer considered as a state threatened or endangered species.

Acknowledgments

Colorado Division of Wildlife personnel supplied much of the information on population estimates and distribution, and participated in transplant projects. We appreciate the contributions of G. Beauprez, R. Hoffman, G. Miller, F. Pusateri, and W. Snyder. Funding was supplied by the Colorado Division of Wildlife through Federal Aid in Wildlife Restoration Project W-167-R.

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Status and Management of the Greater Prairie Chicken in Oklahoma

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Historical Review

Greater prairie chickens *(Tympanuchus cupido pinnatus)*, hereafter referred to as "prairie chickens", formerly ranged across at least the eastern two-thirds of Oklahoma, except in the eastern hardwood forested areas of extreme eastern Oklahoma. By 1941, the range had contracted drastically, approaching a distribution not much larger than the present occupied range (Duck and Fletcher, 1944).

Jacobs (1959) believed that plenty of suitable tallgrass prairie habitat existed in many areas of southern Oklahoma, and that translocations from Osage County (north central Oklahoma) to 4 sites in 3 southern Oklahoma counties were possible and might restore prairie chickens to some of their former range. A total of 314 birds was translocated between 1955 and 1959 (Jacobs, 1959). Although reproduction occurred in the areas of these releases, the translocated populations eventually disappeared.

Martin (1980) estimated that the occupied range of greater prairie chickens in Oklahoma was reduced 42% from 4,065 square miles (10,530 km^2) in 1943 to 2,355 square miles (6,100 km^2) in 1979.

Current Distribution

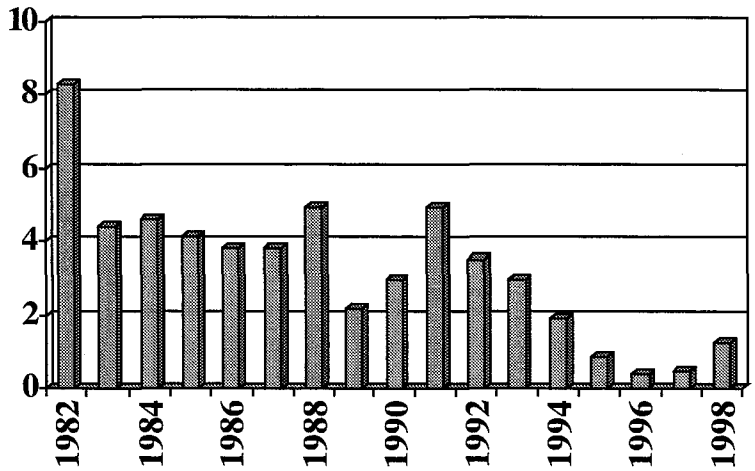
The greater prairie chicken occurs in north central and portions of northeastern Oklahoma. The two largest contiguous tracts occupied by prairie chickens are an area in northern Osage County, which extends into the extreme northeast corner of Kay County. This area also encompasses the more than 37,000 acre (14,974 ha) Tallgrass Prairie Preserve (TGPP), owned and managed by The Nature Conservancy (TNC).

A second area occupied by the greater prairie chicken is the northern portion of Nowata and Craig counties, and also includes the extreme northeastern corner of Washington County. Isolated flocks are known to occur in central Noble County (extends slightly into northwest Pawnee County), Ottawa County northwest of the town of Miami, and in the 3-county area at the confluence of Rogers, Wagoner and Mayes counties.

Population Trends

The population trend since 1979 has been steadily declining with a marked decline beginning in 1990 (Fig. 1). The population now

Figure 1. Greater prairie chicken Population Density Index (number of cocks/booming ground X number of booming grounds/square mile) in Oklahoma.



appears stable, but at a very low level. The long-term outlook for prairie chickens in Oklahoma is stability, with hopes for a steady (although likely quite slow) increase. Land management practices on private land within the core range of prairie chickens will likely determine the actual population trend.

Possible Limiting Factors

One possible limiting factor to prairie chickens in Oklahoma appears to be related to a shift from cow-calf operations to intensive early season grazing on an extremely large scale. Immediately before native, warm-season grasses break dormancy and begin to grow, large tracts of prairie rangeland are burned and then heavily stocked with yearling steers and heifers for the early part of the growing season. Annual burning of extensive acreage immediately prior to nesting, and intensive early growing season grazing over expansive areas might limit the amount of suitable cover for optimal nesting habitat during the earliest part of the nesting season.

Another possible management problem is small mammalian nest predators (skunks, raccoons and opossums). In some areas, herbicides used to eliminate or reduce annual forbs may be a potential problem, especially when used annually and in combination with spring burning. The extent and effects of this practice in Oklahoma are unknown.

A final management problem, and one that certainly merits attention, is the increasingly fragmented nature of the tallgrass prairie landscape. Many areas which once were vast expanses of native prairie have been fragmented to the point that population isolation is common. Extinction of these fragmented populations is occurring quite rapidly, and soon only the core areas along the northern boundary of Oklahoma will be occupied by prairie chickens. The amount of surface limestone and sandstone and the rolling terrain of much of Osage County, combined with the high suitability of the tallgrass prairie for cattle operations may help to preserve large, contiguous tracts of prairie chicken habitat.

Habitat Acquisition

The Oklahoma Department of Wildlife Conservation (ODWC) owns 480 acres (194 ha) in Osage County which was purchased specifically for prairie chicken hunting. Portions of this tract were planted to small grains (primarily milo [*Sorghum* spp.]) to attract birds during the fall hunting season. This practice was stopped in 1996. These lands are currently being allowed to revert back to native prairie vegetation, and will be managed with burning, and limited grazing and/or haying in future years.

The extreme west edge of the Western Wall Unit of the Osage Wildlife Management Area, purchased from The Nature Conservancy, comprises suitable, occupied prairie chicken habitat. This portion of the WMA adjoins TNC's Tallgrass Prairie Preserve. Approximately 90% of this WMA is comprised of timber along Rock Creek, and is therefore not managed for prairie chickens.

The Nature Conservancy, a private conservation organization, has purchased over 37,000

acres (14,974 ha) in north central Osage County – the Tallgrass Prairie Preserve. Bison have been reintroduced as the primary large herbivore and number about 600 animals. Future plans are to allow the herd to expand to a total of about 2,000 head. The entire preserve is managed with prescribed fire and grazing as primary management tools, in hopes of restoring the area to historic land use as nearly as possible. While the TGPP is not managed specifically for prairie chickens, they are an integral part of the tallgrass prairie ecosystem, and therefore, any management practices aimed at restoring and maintaining the vigor of the tallgrass ecosystem should also benefit prairie chickens.

It is unknown whether The Nature Conservancy would be interested in or have the opportunity to purchase additional land to increase the size of the TGPP. There is a need to acquire additional land for prairie chickens in Oklahoma, although the political climate is not conducive for such purchases at this time. Any lands purchased by the state would likely be managed (at least initially) for preservation of prairie chickens. Hopefully, management efforts would be successful and prairie chickens would recover to levels that could support some hunting (Appendix A, Adaptive Harvest Management Strategy).

Probably the best way to assure adequate habitat is available for prairie chickens would be to seek voluntary cooperation from large landowners in areas contiguous with the Tallgrass Prairie Preserve, and in other areas of high prairie chicken densities.

Management

Specific management practices for prairie chickens in Oklahoma on state (ODWC) lands have been limited to food patches. These patches were planted more to attract birds for hunters than provide a winter food source, although providing supplemental winter food was certainly considered and was an intrinsic benefit of these plantings.

The Nature Conservancy's Tallgrass Prairie Preserve is managed as a functional tallgrass prairie ecosystem. Specific management practices include grazing by both bison and cattle (with an increasing emphasis towards bison), and prescribed fire.

Prescribed fire and managed grazing are, without question, the 2 practices which have the most merit in Oklahoma. However, there may be ways that prescribed fire and grazing can be managed differently that would provide more benefit for prairie chickens (e.g. leaving scattered sections unburned or implementing suitable rotational grazing systems).

Research

Since 1997, The George M. Sutton Avian Research Center (GMSARC) has been conducting research on habitat use, survivorship, mortality factors, and nesting success of prairie chickens through radio-telemetry. Additionally, a total of 26 nests was found and monitored during a multi-species, tallgrass prairie birds study between 1992 and 1996. GMSARC personnel also hope to monitor broods of successful hens to determine habitat use and measure brood-rearing success in various management regimes. Some concern has been expressed about the role of retroviruses in Oklahoma prairie-chicken populations. Retroviruses were present in 2 of 17 birds tested in spring 1998. All birds captured in the future will be tested so that the level and effect of these retroviruses can be better ascertained.

While current research information is valuable in properly managing prairie chickens, much of the published research has dealt with large populations of birds occupying large contiguous tracts of suitable habitat (Jones 1963a,b). Habitat fragmentation and population isolation have become increasingly common in Oklahoma. In addition, annual large-scale spring burning and early intensive cattle grazing now dominate the landscape in the heart of prairie-chicken range in Oklahoma. The effects of these phenomena on prairie chickens need to be evaluated and relevant management recommendations put forth.

Hunting and Harvest Pressure

Greater prairie chickens were hunted in Oklahoma during the fall of 1997 (18–19 October; bag limit: 1 bird/day; season limit: 2 birds). At the August 1997 meeting of the Oklahoma Wildlife Commission, the prairie chicken season was closed, effective beginning with the 1998 season. The Commission approved an Adaptive Harvest Management Strategy whereby the season would re-open if certain population parameters indicated recovery of prairie chickens to population levels at which hunting would be warranted (Appendix A). The earliest that the season could possibly re-open would be in the fall of 2002.

Although the final harvest estimate for 1997 is not yet available pending the results of the 1997 Game Harvest Survey, the total estimated harvest is likely less than 200 birds (including lesser prairie chickens [*Tympanuchus pallidicinctus*]). If prairie chickens are hunted in the future, the approved Adaptive Harvest Management Strategy will be utilized as a safeguard to ensure against over harvest.

Habitat Management Recommendations

PASTURE MANAGEMENT

- Grazing should be light to moderate, especially within ½ mile (0.8 km) of known booming grounds, to ensure adequate, high quality nesting cover.
- Spot treatment with heavy (season-long) grazing should be utilized to promote growth of native annual forbs for food and brood-rearing cover.
- Hay meadows should be cut between 1 July and 15 July, and native grass should never be cut more than once per season.
- Minimize herbicide use, using spot treatment only where necessary and/or spray small areas on a 2- to 3-year rotation.
- Convert non-native pasture to a mixture of warm-season native grasses, making sure to include a mixture of native forbs and legumes.

CONTROLLED BURNING

- Complete all burning a month prior to nest initiation.
- Rotate pastures (2–3 years) and burn in a mosaic pattern.
- Keep burn units small (≤640 acres [259 ha]) where possible.

SUPPLEMENTAL FOODS

- Native annual forbs and legumes are preferred.
- If supplemental plantings are desirable, plant small 10–15 acre (4–6 ha) patches, 1 or 2 per square mile (259 ha). Plots should be oblong (rather than square), planted along topographic contours, and adjacent to high quality winter / escape cover.

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Appendix A. Adaptive Harvest Management Strategy for Prairie Chickens In Oklahoma.

JULY 1997
ADAPTIVE HARVEST MANAGEMENT STRATEGY FOR PRAIRIE CHICKENS IN OKLAHOMA

It is proposed that the hunting season for both the lesser prairie chicken and greater prairie chicken be closed in Oklahoma.

Populations of both species have shown a gradual but continuous long-term decline, but over the past 6–8 years, this decline has accelerated and become much more obvious. For this reason, the hunting season for both species was reduced from 9 days in mid-November (daily bag limit 2, possession limit 4) to a 2-day season in late October (daily bag limit 1, possession limit 2). Populations have continued to decline, and although the Oklahoma Department of Wildlife Conservation does not consider the decline to be in any way caused by nor related to legal recreational hunting, the ODWC feels that hunting of either species should be curtailed until populations recover, and is therefore recommending closing the hunting season for both species.

This recommended closure should remain in effect only until populations have recovered to levels at which sustained hunting is warranted. The following are the conditions under which the season will be re-opened, and include population-related season and bag limit frameworks.

GREATER PRAIRIE CHICKEN

A 2-day season will be opened in Craig, Kay, Noble, Nowata, Osage and Washington counties when all of the following population parameters are met in at least 4 of these 6 counties:

1. Population indices in at least 4 of the above counties indicate an increasing population in 4 or more of 5 successive years, and

2. The average number of booming males / active booming ground is 5 or more for 4 or more of 5 successive years, and

3. Average booming ground densities in the above counties, as determined by current survey methods, are at least .25 booming grounds / square mile (259 ha), for 4 or more of 5 successive years, and

4. The Population Density Index (# booming males X booming ground density) is 3.0 or higher for 4 or more of 5 successive years.

The season will be opened for 2 days only, the fourth weekend in October. The daily bag limit will be 1 greater prairie chicken, and the possession limit will be 2 greater prairie chickens.

Shooting hours will be ½ hour before legal sunrise to legal sunset. A 4-day season will be opened in Craig, Kay, Noble, Nowata, Osage and Washington counties when all of the following criteria are met in at least 5 of the above counties:

1. The 2-day season described above has been opened in each of the 3 previous years,

2. Population indices in at least 5 of the above counties indicate an increasing population in 4 or more of 5 successive years, and

3. The average number of booming males / active booming ground is 7 or more for 4 or more of 5 successive years, and

4. Average booming ground densities in the above counties, as determined by current survey methods, are at least .30 booming grounds / square mile (259), for 4 or more of 5 successive years, and

5. The Population Density Index (# booming males X booming ground density) is 4.0 or higher for 4 or more of 5 successive years.

Season dates will be the second Thursday before Thanksgiving through the following Sunday (4 days). Daily bag limit will be 2 greater prairie chickens, and possession limit is 4 greater prairie chickens. Legal shooting hours will be daylight to dark.

A 9-day season will be opened in Craig, Kay, Noble, Nowata, Osage and Washington counties when all of the following criteria are met in at least 5 of the above counties:

1. The 4-day season described above has been opened in each of the 3 previous years,

2. Population indices in at least 5 of the above counties indicate an increasing population in 4 or more of 5 successive years, and

3. The average number of booming males / active booming ground is 8 or more for 4 or more of 5 successive years, and

4. Average booming ground densities in the above counties, as determined by current survey methods, are at least .35 booming grounds / square mile (259 ha), for 4 or more of 5 successive years, and

5. The Population Density Index (# booming males X booming ground density) is 5.0 or higher for 4 or more of 5 successive years.

Season dates will be the second Thursday before Thanksgiving through the Sunday prior to Thanksgiving (9 days). Daily bag limit will be 2 greater prairie chickens, and possession limit will be 4 greater prairie chickens. Legal shooting hours will be daylight to dark.

Hunting season for greater prairie chickens will comprise the following 4 levels:

- Closed Season
- 2-day October Season
- 4-day November Season
- 9-day November Season

Hunting season for greater prairie chickens will be opened at the most liberal level allowed under the above-described framework.

LESSER PRAIRIE CHICKEN

A 2-day season will be opened in Beaver, Ellis, Harper, Texas and Woodward counties when all of the following population parameters are met in at least 4 of these 5 counties:

1. Population indices in at least 4 of the above counties indicate an increasing population in 4 or more of 5 successive years, and

2. The average number of booming males / active booming ground is 6 or more for 4 or more of 5 successive years, and

3. Average booming ground densities in the above counties, as determined by current survey methods, are at least .25 booming grounds / square mile (259 ha), for 4 or more of 5 successive years, and

4. The Population Density Index (# booming males X booming ground density) is 3.0 or higher for 4 or more of 5 successive years.

The season will be opened for 2 days only, the fourth weekend in October. The daily bag

limit will be 1 lesser prairie chicken, and the possession limit will be 2 lesser prairie chickens. Shooting hours will be ½ hour before legal sunrise to legal sunset.

A 4-day season will be opened in Beaver, Ellis, Harper, Texas and Woodward Counties when all of the following criteria are met in at least 4 of the above counties:

1. The 2-day season described above has been opened in each of the 3 previous years,

2. Population indices in at least 4 of the above counties indicate an increasing population in 4 or more of 5 successive years, and

3. The average number of booming males / active booming ground is 7 or more for 4 or more of 5 successive years, and

4. Average booming ground densities in the above counties, as determined by current survey methods, are at least .30 booming grounds / square mile (259 ha), for 4 or more of 5 successive years, and

5. The Population Density Index (# booming males X booming ground density) is 4.0 or higher for 4 or more of 5 successive years.

Season dates will be the second Thursday before Thanksgiving through the following Sunday (4 days). Daily bag limit will be 2 lesser prairie chickens, and possession limit is 4 lesser prairie chickens. Legal shooting hours will be daylight to dark.

A 9-day season will be opened in Beaver, Ellis, Harper, Texas and Woodward Counties when all of the following criteria are met in at least 4 of the above counties:

1. The 4-day season described above has been opened in each of the 3 previous years,

2. Population indices in at least 4 of the above counties indicate an increasing population in 4 or more of 5 successive years, and

3. The average number of booming males / active booming ground is 8 or more for 4 or more of 5 successive years, and

4. Average booming ground densities in the above counties, as determined by current survey methods, are at least .35 Booming grounds / square mile, for 4 or more of 5 successive years, and

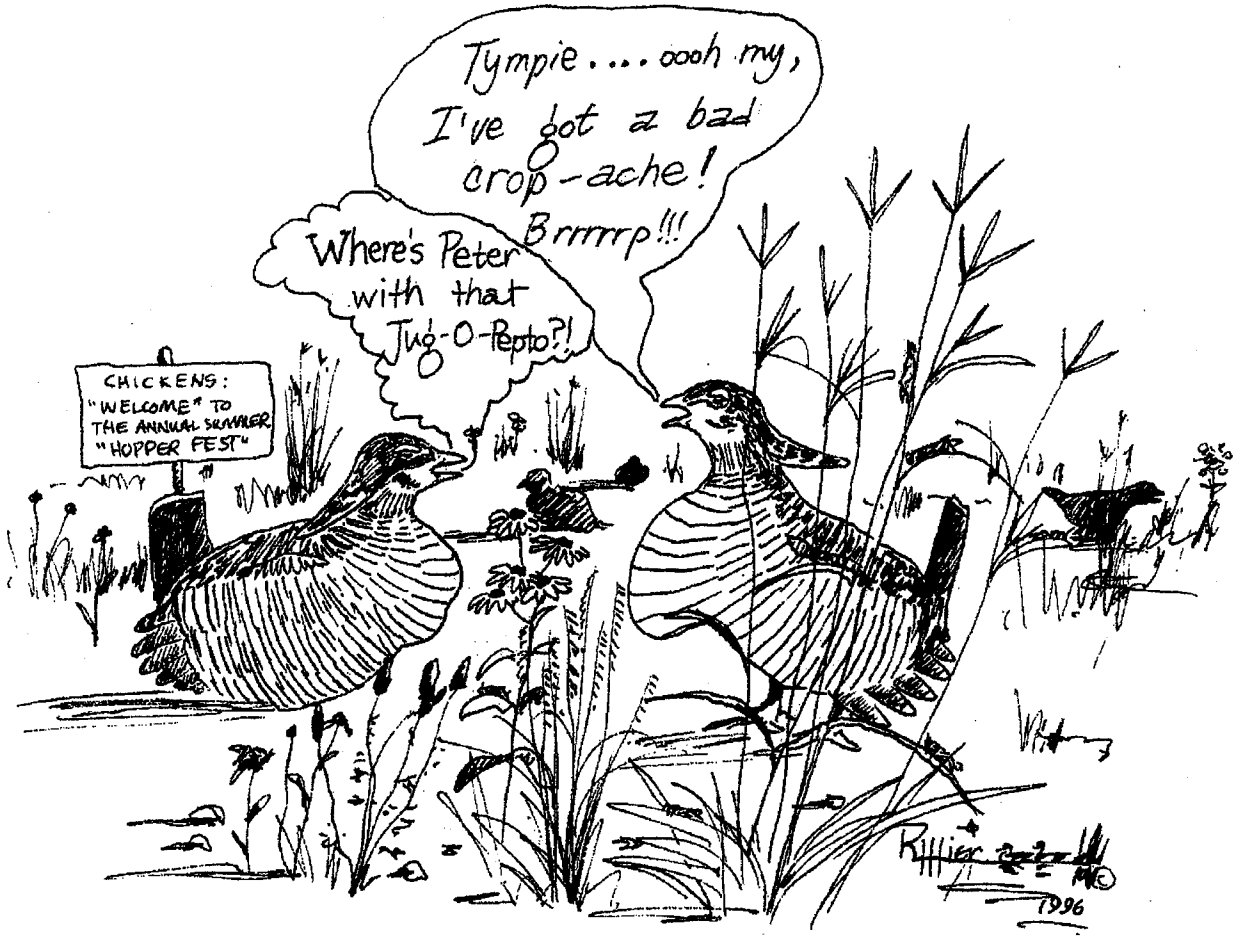
5. The Population Density Index (# booming males X booming ground density) is 5.0 or higher for 4 or more of 5 successive years.

Season dates will be the second Thursday before Thanksgiving through the Sunday prior to Thanksgiving (9 days). Daily bag limit will be 2 lesser prairie chickens, and possession limit will be 4 lesser prairie chickens. Legal shooting hours will be daylight to dark.

Hunting season for lesser prairie chickens will comprise the following 4 levels:

- Closed Season
- 2-day October Season
- 4-day November Season
- 9-day November Season

Hunting season for lesser prairie chickens will be opened at the most liberal level allowed under the above-described framework


Tympie.... oooh my, I've got a bad crop-ache! Brrrrrp!!!
Where's Peter with that Jug-O-Pepto?!
CHICKENS: "WELCOME" TO THE ANNUAL SUMMER "HOPPER FEST"
1996

Status and Management of the Greater Prairie Chicken In Kansas

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Historical Review[1]

Historically there were 3 species of prairie grouse in Kansas, the plains sharp-tailed grouse (*Tympanuchus phasianellus jamesii*), lesser prairie chicken (*T. pallidicinctus*), and greater prairie chicken (*T. cupido pinnatus*). The greater prairie chicken was, and still is, the most common prairie grouse species in Kansas. Beginning with settlement, land-use changes from grassland to cropland have influenced prairie chicken populations and range. Greater prairie chicken populations initially increased, but later dwindled as land conversion continued. The Flint Hills of east-central Kansas now remain their stronghold, with smaller populations to the east and west.

Historical records of prairie chickens in Kansas are rare. The accounts of early explorers mention little of the bird, which may indicate that they did not occur in substantial numbers. Pike did not mention the prairie chicken in his account of travels across Kansas in the autumn of 1806 (Coues 1895). While observing prairie chickens twice in Missouri, Tixier never mentioned seeing them during his travels in 1840 to an Osage Indian Village probably located in southeast Kansas (McDermott 1940). Even more significant was the fact that part of his party survived for 2 days on upland sandpipers (*Bartramia longicauda*) during their stay on the prairie. Had prairie chickens been available, they no doubt would have also been used as food.

Territorial and state laws governing the harvest and use of prairie chickens in Kansas probably present the most complete records available (Wood 1964). These laws, though initially unscientific, reveal a general concern for the population.

In 1861, the last Territorial Legislature imposed the first hunting season for prairie chickens in Kansas (2 November to 31 March). No limits or methods of taking birds were stated, however, Leavenworth County landowners were allowed to take the birds year-round on their own land. This could indicate a greater abundance of birds or favoritism toward the landowner in extreme northeastern Kansas. The season never actually occurred because, in the same year, the formation of the first Kansas State Legislature resulted in game law changes. The new legislature apparently gave county governments authority over seasons.

[1] *Taken largely from Horak (1985)*

As a result, the season opened on 2 September rather than 2 November, statewide. The law provided that the season could be closed in any county if a minimum of 20 citizens of that county petitioned for closure. There is no evidence that any county exercised this option (Wood 1964).

The law remained unchanged until 1865, when the legislature removed state protection of the prairie chicken, but left open the option to counties to close hunting in their own jurisdictions. Again, there is no record of any counties doing so. No governmental body provided enforcement of the laws affecting prairie chickens (Wood 1964).

With further settlement of Kansas in the late 1860s and 1870s, agricultural activity increased and the prairie chicken population responded. Farming made range expansion possible due to new winter food supplies. Early farming efforts seemingly provided excellent habitat. Koch (1863) indicated that prairie chicken numbers increased within 3 years after settlement. In an ornithological survey in 1872, J.A. Allen noted that the prairie chicken was rare, but was advancing westward every year. Prairie chickens were first seen in the vicinity of Fort Hays around 1870 and were apparently fast becoming common (Goss 1891).

During the late 1800s, new settlements were being established in western Kansas, and the accompanying agriculture helped move the prairie chicken west. Cooke (1900) reported that prairie chickens first nested in Colorado in approximately 1899.

Kansas laws were liberalized during the 1870s suggesting increased prairie chicken numbers. Nets and traps were illegal in 1868, but by 1876, landowners could use them to catch birds on their own property. In 1877, prairie chickens could be taken by anyone, anyplace, by any means, but commercial shipment of any game animal out of the state was illegal (Wood 1964).

The decline of prairie chicken populations in Kansas was noted as early as 1891, when Goss (1891) reported that birds were rapidly decreasing in numbers, and that, unless the law protecting them was strictly enforced, especially relative to trapping, prairie chickens would soon be exterminated. During periods of extreme cold and snow cover, hunger overcame fear and chickens were easily trapped. In 1912, Dyche noted that prairie chickens were previously found in great numbers, especially in eastern Kansas, but as of that date they were restricted mainly to counties in the western part of the state (Bunker 1913). Bunker noted that, while prairie chickens were fairly common in western Kansas, they were no longer so abundant in some areas.

At some point, agriculture provided an optimum balance of food and cover for prairie chickens, but they rapidly disappeared once this balance was exceeded. The decline was probably accelerated by subsistence and market hunting and natural population fluctuations. There is no question that the major long-term impact resulted from expansion of cultivation and the subsequent loss of prairie habitat. Unlike most tallgrass prairie regions, the Flint Hills of Kansas escaped heavy cultivation and consequently maintained good prairie chicken populations during the agricultural revolution.

In the early 1900s, public concern for the welfare of prairie chicken populations grew and many Kansas county commissions closed their counties to hunting. From 1903 through 1905, 20 Kansas counties closed their seasons. All of these were in the western half of the state, with 17 in the southwest. In 1907, Butler County government made prairie chicken hunting illegal for 3 years. The statewide daily bag limit of 15 was imposed in 1905 and was lowered to 12 in 1911 (Wood 1964).

Despite all efforts, prairie chicken numbers continued to decline, suggesting that hunting was not solely responsible. There was no prairie chicken season in Kansas from 1913 through 1916. By 1922, prairie chicken populations had stabilized in the eastern portions of Kansas and were found wherever conditions were favorable. This included the extreme eastern counties, where they were nearly extirpated 10 years earlier (Clapp 1922).

During the 1920s, more regulations were established, and market hunting stopped. Season limits of 20 birds and shooting hours of one-half hour before sunrise to sunset were first established in 1921. In addition, only 11 hunting days were allowed from 1921 through 1926. The Kansas Forestry, Fish and Game Commission was established in 1926, further increasing the ability of the state to impose and enforce game laws. The commission imposed a statewide closed season on prairie chickens in 1927 in hopes of protecting lesser prairie chickens in the southwestern portion of Kansas (Wood 1964).

During the early 1930s, populations of prairie chickens fluctuated greatly due to drought conditions (Schwilling 1955, Baker 1953). From 1931 through 1935, the season was only 2 days long. The severe drought during the late 1930s may have reduced the hatching rate of prairie chickens (Stempel and Rodgers 1961). Prairie chicken hunting seasons in Kansas were closed from 1936 through 1940 during the height of the drought (Wood 1964). It is likely that changes in agriculture and overgrazing that accompanied the drought all but eliminated prairie chickens from northwest Kansas and drastically reduced populations elsewhere (Baker 1953).

From 1941-43, short hunting seasons were opened in certain areas of the state. Six southeast counties (Woodson, Allen, Anderson, Linn, Bourbon, and Crawford) were open to hunting in 1941. Greenwood, Franklin, and Wilson were added in 1942 and 1943, while Linn County remained closed (Wood 1964).

The season was closed again in 1944 and remained closed through 1950. Hunters were allowed to take 2 birds during 1-day seasons (25 October) in 1951 and 1952. The only areas open to hunting in the state were counties in or near the Flint Hills (Wood 1964).

The season was again closed from 1953 until 1956. In 1956, an attempt to reopen the prairie chicken season failed due to fears that hunting coupled with drought conditions, would be detrimental to the birds. A season was established in 1957 and every year since (Table 1) (Wood 1964).

Table 1. Greater prairie chicken hunting seasons in Kansas, 1957-96.

Year	Season length (Days)	Daily bag limit	Possession limit	Number of counties open
1957	2	2	4	19
1958	2	2	4	19
1959	3	2	4	27
1960	3	2	4	28
1961	3	2	4	28
1962	5	2	4	29
1963	3	2	4	29
1964	5	2	4	29
1965	3	2	4	29
1966	9	2	4	29
1967	9	2	6	29
1968	7	2	6	29
1969	11	2	6	51
1970	4	2	4	51
1971	4	2	6	51
1972	18	2	6	51
1973	30	2	6	51
1974	28	2	6	59
1975	9	2	4	statewide
1976	30	2	6	statewide
1977	37	2	6	41
1978	44	2	6	51
1979	59	2	6	statewide
1980	61	2	6	statewide
1981	101	2	6	statewide
1982	88	2	6	statewide
1983	89	2	6	statewide
1984	90	2	6	statewide
1985	91	2	6	statewide
1986	92	2	6	104
1987	86	2	6	104
1988	88	2	6	104
1989	23,89[1]	2	6	statewide
1990	30,90	2	6	statewide
1991	23,91	2	6	statewide
1992	31,86	2	6	66,statewide [1]
1993	31,87	2	6	66,statewide
1994	31,88	2	6	66,statewide
1995	31,89	2	6	66,statewide
1996	31,90	2	6	66,statewide

[1] Starting in 1989, and in subsequent years, there has been an "early" walk-up hunting season in addition to the "regular" fall season. The first numeral reflects the length and open area of the early season, and the second numeral is for the regular season.

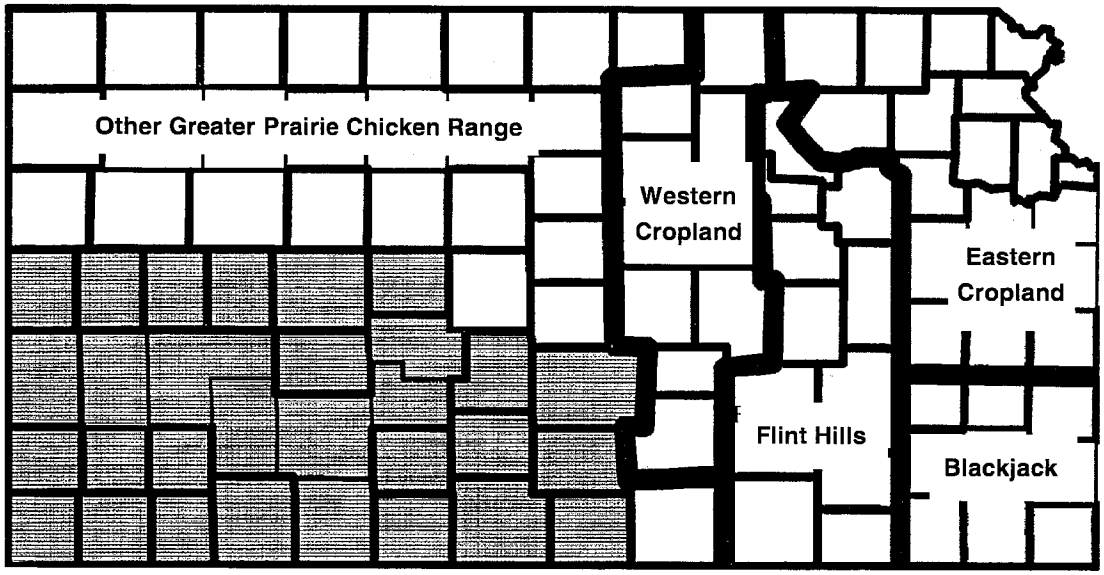


Figure 1. Distribution and survey regions for greater prairie chickens in Kansas. The shaded counties represent lesser prairie chicken range.

European agricultural influence was a early positive factor in the expansion of the prairie chicken in Kansas. Only after man amplified agricultural operations did the prairie chicken suffer. Intensified land use and changes in the prairie plant composition during the late 1800s started the downward trend. Though populations fluctuated widely during the first half of the 20th century, the numbers of the 1800s were never repeated. The drought years of the 1930s and 1950s drastically reduced the numbers and range of Kansas prairie chickens. Since that time, Kansas prairie chickens have again gradually increased their range and populations with considerable fluctuation.

Greater prairie chickens are presently found throughout eastern and northern Kansas (Fig. 1). Most of southwestern and south-central Kansas is considered to be lesser prairie chicken range. It is possible that both greater and lesser prairie chickens occur in some
areas of south-central Kansas, particularly Stafford and Barton Counties, as well as other areas in western Kansas south of Interstate 70 and west of U. S. Highway 281.

Censusing and Surveys

BOOMING GROUNDS

Booming ground or lek surveys are conducted annually in spring from 20 March to 20 April along 28, 10-mile (16.1 km) routes established in typical greater prairie chicken habitat. Eleven booming ground survey routes have been conducted since 1963 (Horak 1985) with 17 additional routes added in subsequent years.

The listening component of the survey begins 40 minutes before sunrise. The observer stops at 1-mile (1.6 km) intervals along the route and listens for booming males for 3 minutes within a 1-mile (1.6 km) radius of the stop. Booming ground locations are marked on a route map. At the end of the listening component, the observer retraces the route, locates each booming ground and flushes birds for a total count (males plus females). For the purposes of this survey we define a booming ground as an area where 2 or more male prairie chickens are displaying.

Only booming grounds located within the defined 12.9 mi^2 (32.2 km^2) area covered by

a route are considered in analyses. Indices are calculated for both booming grounds and prairie chickens/mi² (2.59 km²). Data are pooled by regions (Fig. 1) and only prairie chicken densities will be discussed here. We have 34 years of booming ground survey data from the 4 regions (Fig. 1) and range-wide. All survey regions show peak greater prairie chicken numbers in the late 1960s and early 1980s with declines occurring thereafter (Fig. 2). Lowest densities occurred in the period 1990, 1994, and 1996, with a slight recovery in 1997.

RURAL MAIL CARRIER SURVEY (RMCS)

A Rural Mail Carrier Survey is conducted 4 times per year during the last full calendar week of July (1962-present), January (1963-present), April (1963-present), and during mid-October (1966-present). Standard prepaid post cards are distributed to the postmasters of all Kansas post offices having rural

Figure 2. Greater prairie chicken booming ground survey trends in Kansas, 1963-1996. Index = birds/ square mile (2.59 km²) and includes prairie chickens of both sexes.

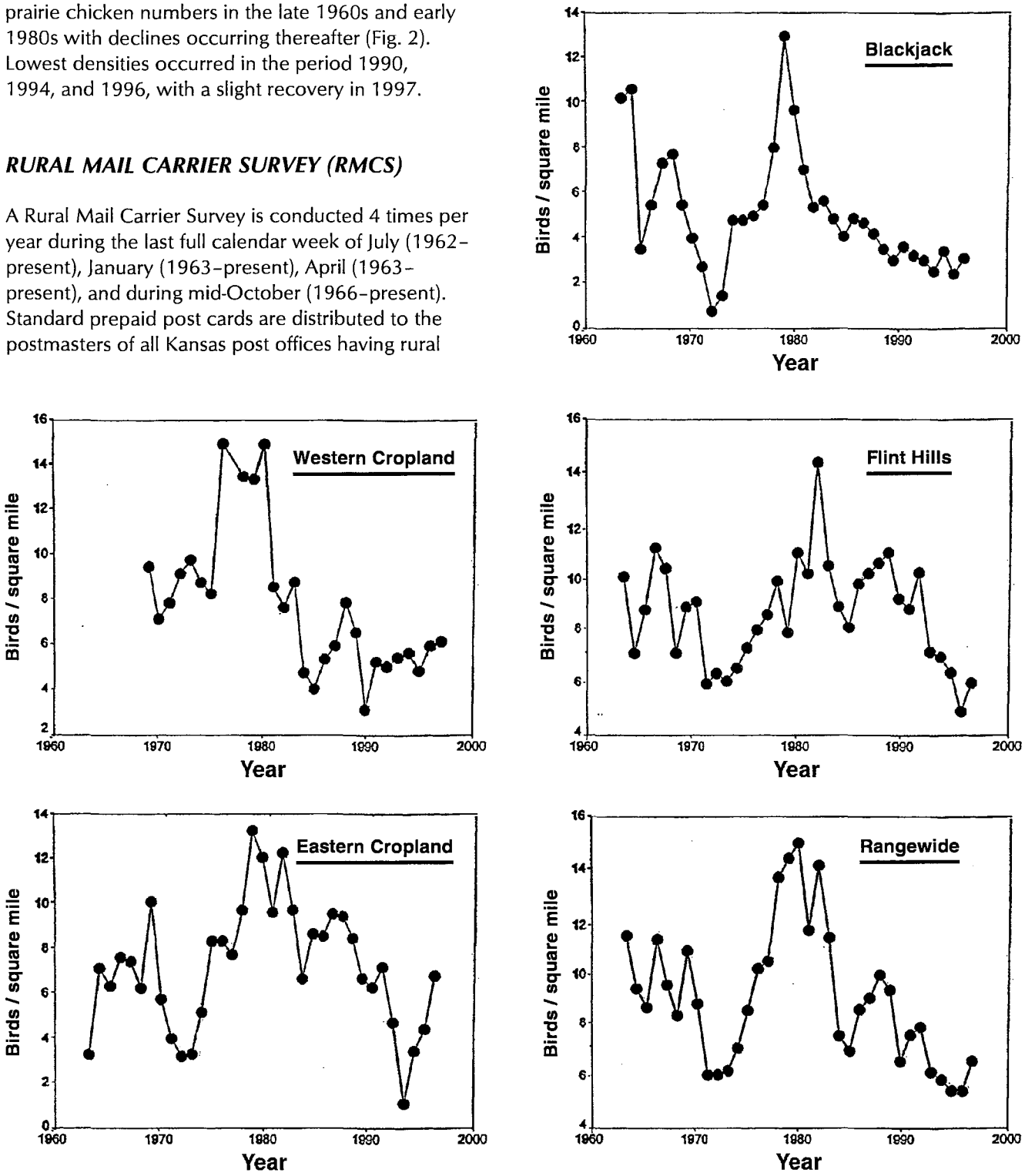
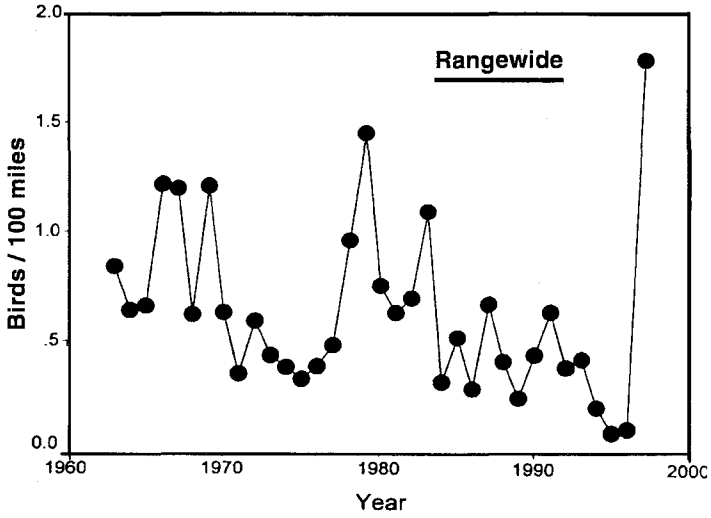
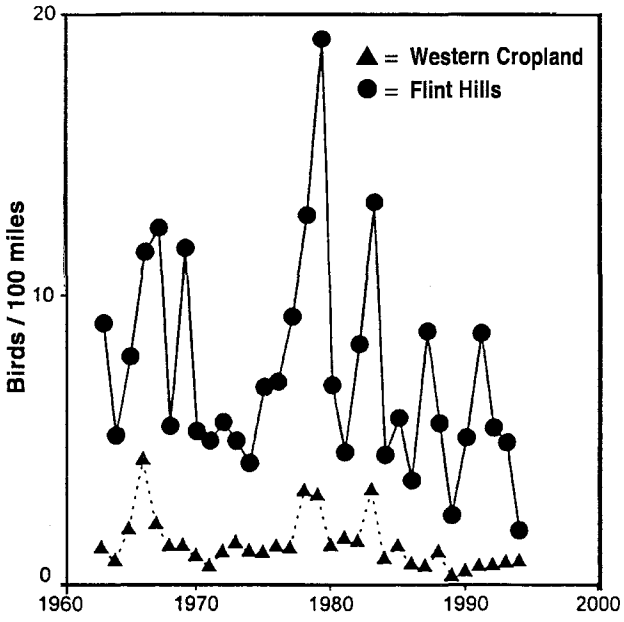
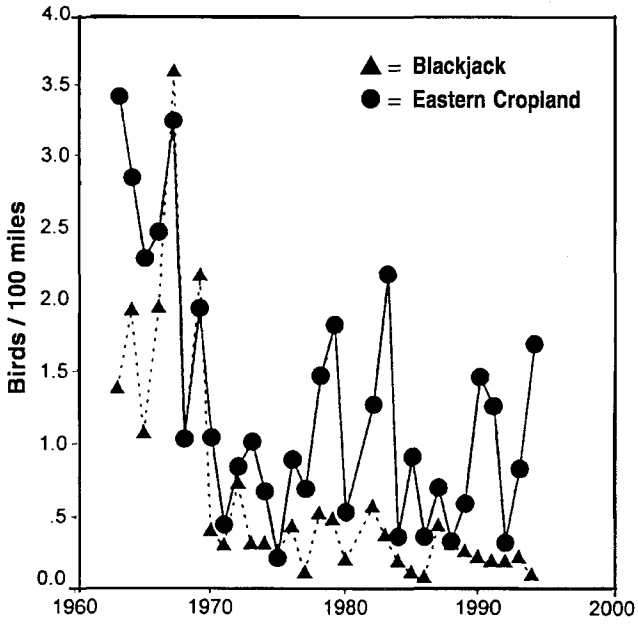


Figure 3. Rural Mail Carrier Survey trends for greater prairie chickens in Kansas by region (Blackjack, Eastern Cropland, Flint Hills, and Western Cropland) and across the entire range, 1963-1994. Index = birds/100 miles (161 km) and includes prairie chickens of both sexes.







routes. Carriers are asked to record the number of miles driven during the survey week and the numbers of animals seen by species. An index of prairie chickens/100 miles (161 km) is calculated from these data. Data are pooled by regions (Fig. 1) and indices are means of each annual cycle of 4 surveys. We have 34 years of RMCS data, but this paper only includes data through 1994.

The trends shown in the RMCS data are similar to booming ground surveys except that there is more fluctuation in the numbers of birds/route (Fig. 3). Also evident from these data are increases in numbers in 1994 in all regions except the Flint Hills.

Harvest and Hunting Pressure

Each year prior to the upland gamebird hunting seasons, 5% of the previous year's general hunting license purchasers are contacted by mail and asked to maintain a record of their hunting activity on a survey card. At the close of the upland bird hunting seasons, each person in the sample is mailed a questionnaire which they are asked to fill out detailing their hunting activity for that year and return the card to the Kansas Department of Wildlife and Parks (KDWP). Each non-respondent is sent a second mailing with the same questionnaire card. Generally about 4% of those con-

tacted return usable data which equates to ~2% of the current year's license buyers. One reason for a low response rate is that a general license is required in order to purchase big game permits; some purchasers of a license may have only hunted big game species. Indices calculated include percent of respondents hunting a species, average bag/day, days hunted/season, and total season bag/hunter. These data are expanded using known total hunting license sales to estimate total hunters and total statewide harvest of each species (Landwehr 1982). Harvest estimates for greater prairie chickens are available for a 39-year period, 1957-1996 (Table 2).

Overall, estimated harvests have remained stable based on linear regression (Fig. 4). However, because the estimated harvest for any given year will be auto-correlated with the previous year's estimates, time-series analyses are necessary to accurately model trends (Ostrom 1978). Since time-series analyses will be presented in a future paper, we present these data to show generalized trends.

Species Needs

Continued changes in land use have influenced both the distribution and abundance of prairie chickens in Kansas. The extent of these changes on population density and distribution are unknown.

KDWP is conducting research , under contract with Kansas State University, to address effects of observer variability on booming ground counts. In addition, an effort is being made to assess effects of route-specific land use change on booming ground survey results. Models will be developed to correct future surveys for such variables as starting time and duration of count.

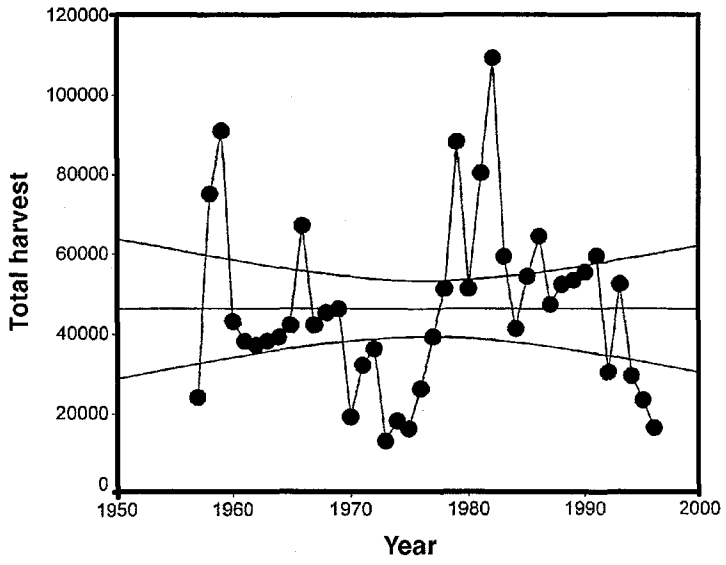
Management Needs

A shift from season-long (May–October) steer operations to early intensive (Launchbaugh et al. 1983) grazing systems in recent years has had an unquantified impact on prairie

Table 2. Estimates of greater prairie chicken harvests during Kansas hunting seasons, 1957-96.

Year	Early season	Regular season	Total
1957	—	—	24,000
1958	—	—	75,000
1959	—	—	91,000
1960	—	—	43,000
1961	—	—	38,000
1962	—	—	37,000
1963	—	—	38,000
1964	—	—	39,000
1965	—	—	42,000
1966	—	—	67,000
1967	—	—	42,000
1968	—	—	45,000
1969	—	—	46,000
1970	—	—	19,000
1971	—	—	32,000
1972	—	—	36,000
1973	—	—	13,000
1974	—	—	18,000
1975	—	—	16,000
1976	—	—	26,000
1977	—	—	39,000
1978	—	—	51,000
1979	—	—	88,000
1980	—	—	51,000
1981	—	—	80,000
1982	—	—	109,000
1983	—	—	59,000
1984	—	—	41,000
1985	—	—	54,000
1986	—	—	64,000
1987	—	—	47,000
1988	—	—	52,000
1989	6,000	47,000	53,000
1990	13,000	42,000	55,000
1991	15,000	44,000	59,000
1992	4,000	26,000	30,000
1993	10,000	42,000	52,000
1994	11,000	18,000	29,000
1995	4,000	19,000	23,000
1996	5,000	11,000	16,000

Figure 4. Linear regression (r^2= 0.0001, P= 0.973) trends of greater prairie chicken harvest estimates in Kansas, 1957-1996.



chicken populations. Early intensive grazing involves stocking of steers at ~2 times the normal rate of 3.4 acres/steer (1.4 ha/steer) in early May. Cattle are then removed in mid-July, instead of early October, and shipped to feedlots for finishing.

There has also been an increase in annual burning of entire pastures instead of less thorough burning as in the past. Since burning is conducted in March and April, this means that any residual vegetation produced after mid-July under the early intensive system is burned before prairie chicken nesting or during egg laying. Nesting cover, particularly residual vegetation, is essential for prairie chicken nesting habitat (Westemeier 1972, Buhnerkempe et al. 1984).

Several general guidelines have been prepared for enhancing greater prairie chicken populations in Kansas (Applegate and Horak 1998). These are:

1. Maintain a grassland/cropland interspersion of 75:25 on the landscape.

2. Maintain large and moderately grazed pastures to provide a diversity of grassland types.

3. Controlled burning every 3 or 4 years to maintain pastures to improve cattle forage, retard woody vegetation encroachment, remove excess residual vegetation, and maintain plant vigor.

4. Booming grounds (~10% of the pasture area) should be overgrazed to provide vegetation ~2 in. (5cm) in height.

5. Nesting habitat (15% of pasture area) should be maintained by light grazing at a height of ~15 in. (~38 cm).

6. Brood habitat and winter loafing and roosting habitat (75% of pasture area) should be maintained in medium to tall vegetation.

7. Grain fields (minimum of 15 acres [6 ha]) planted to soybeans, sorghum, winter wheat or corn will furnish winter food and fields for hunters to harvest prairie chickens.

Public Needs

KDWP is providing 2 prairie chicken viewing blinds in the Flint Hills. Blind space is reserved on a first-come, first-served basis. A report card is supplied to each group using the blinds to collect information of visitation rate and data on activities and number of prairie chickens present on the grounds. The primary purpose of these data is to document visitor use of the blinds and possible effects of public use on the birds. Blinds are located on private lands.

Acknowledgments

This paper is a contribution of Kansas Federal Aid to Wildlife Restoration Project W-39-R and its predecessors. Numerous KDWP personnel have contributed to prairie chicken research and management over the years. We especially thank former project leaders J. Norman, K. Sexson, R. Wells, K. Church, and current project assistant R. Rodgers,

R. Westemeier, W.D. Svedarsky, and W. Jensen provided helpful suggestions on the manuscript. A. Schleicher typed and edited portions of the manuscript.

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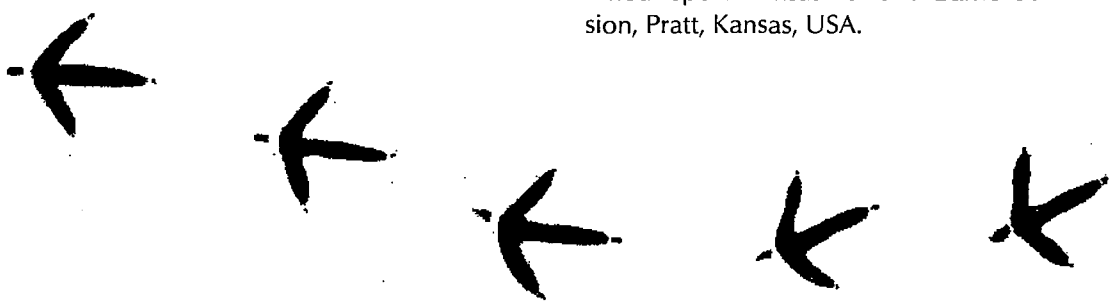
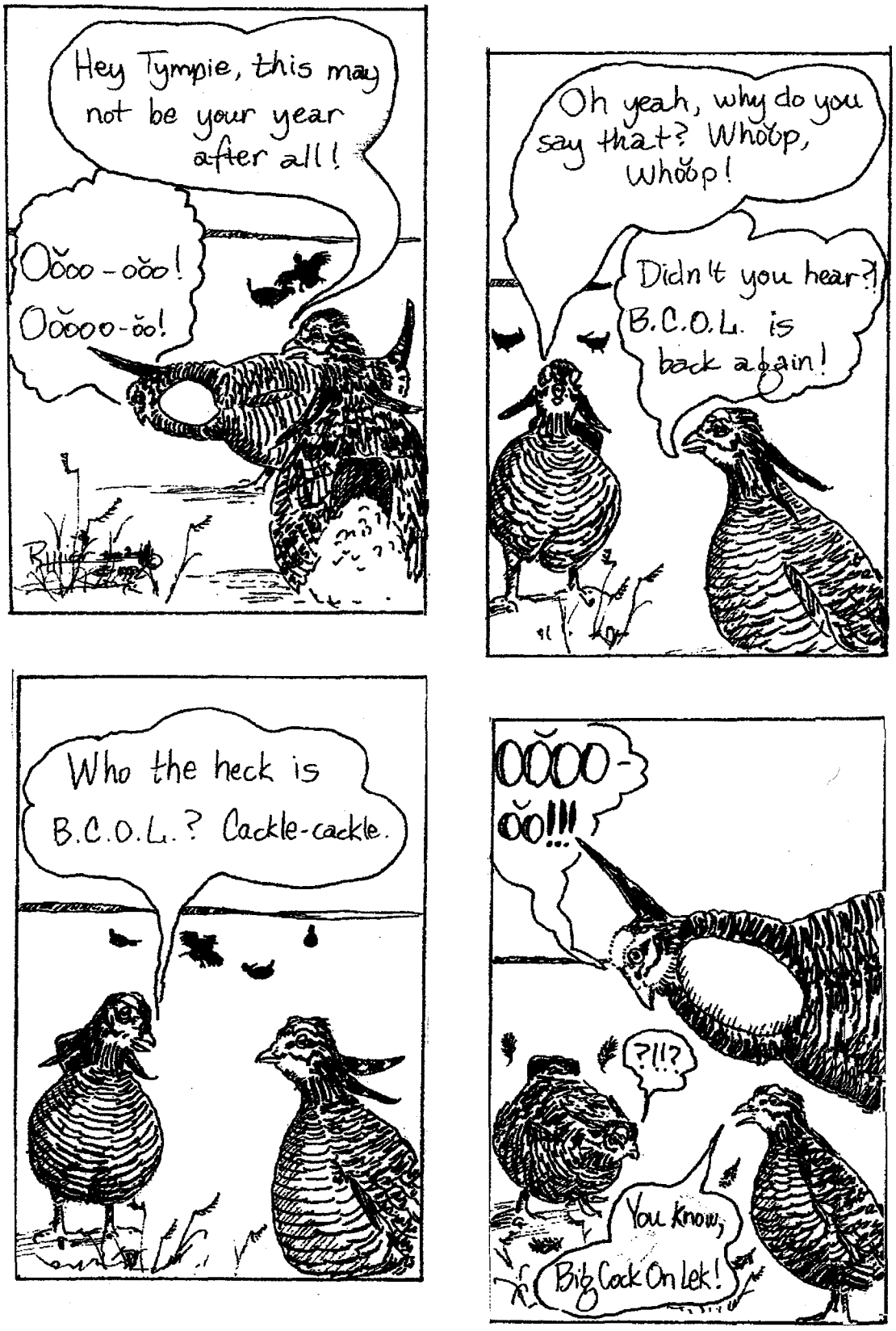



Hey Tympie, this may not be your year after all!
Oŏoo-oŏo!
Oŏooo-ŏo!
Oh yeah, why do you say that? Whoŏp, Whoŏp!
Didn't you hear? B.C.O.L. is back again!
Who the heck is B.C.O.L.? Cackle-cackle.
OŎOO-ŏo!!!
?!!?
You know, Big Cock On Lek!

Status and Management of the Greater Prairie Chicken in Iowa

Mel Moe, Iowa Department of Natural Resources, Mount Ayr

Historical Review

At the time of European settlement in the mid-nineteenth century and until about 1900, greater prairie chickens (*Tympanuchus cupido pinnatus*) commonly nested throughout the state of Iowa. Numbers peaked about 1880 when most of Iowa was a mosaic of small grainfields, hayfields, pasture, and native prairie which provided ideal habitat conditions (Ehresman 1996).

Prairie chickens were the most abundant gamebird on the Iowa prairies and hunting and trapping them was very important to settlers, both for food and market. Bags of 25 to 50 a day were common, and some hunters took up to 200 a day. By 1878, Iowa lawmakers were apparently concerned that prairie chickens were being over-harvested and passed a law limiting the daily bag to 25 birds per person. This is believed to be the first time that bag limits were used as a tool to regulate the harvest of game in the United States. Additional restrictions followed, and the last open season for prairie chickens in Iowa was held in 1915 (Stempel and Rodgers 1961).

As agricultural land use intensified, populations of prairie chickens started to decline. By the 1930s, most prairie chickens found in the northwestern part of the state were migrant winter flocks, with only a few nesting along the northern, northeastern, and southern borders of the state. By the 1950s, the only known nesting prairie chickens were in Appanoose, Wayne, and Ringgold Counties in southern Iowa (Fig. 1). The last verified nesting prior to reintroduction attempts was in Appanoose County in 1952 (Stempel and Rodgers 1961).

Reintroduction Projects

FIRST ATTEMPT

In the early 1980s, the Iowa Conservation Commission, now the Iowa Department of Natural Resources (IADNR), made an attempt to restore prairie chickens to west central Iowa. The IADNR negotiated with the Kansas Fish and Game Commission, now Kansas Department of Wildlife and Parks (KSDWP), to trade wild turkeys for 100 prairie chickens. The release site was in the loess hills east of Onawa (Site 1, Fig. 2), an area of steep to moderately rolling bluffs and hills bordering the Missouri River valley with large expanses of grassland interspersed with brush and small crop fields. Fifty-three prairie chickens were released in 1980 and 48 in 1982. A few booming grounds were established, and 2 broods were reported, but most sightings were in the more agricultural Missouri River valley instead of the hills where birds were released. Apparently, prairie chickens preferred the more level valley land to the hilly release area, but suitable grasslands were

lacking in the valley. Only occasional sightings have been reported in this region since 1984, suggesting that this reintroduction effort was probably a failure (Ron Munkel, IADNR, personal communication).

Figure 1. Iowa counties known to have nesting prairie chickens, 1950-53.

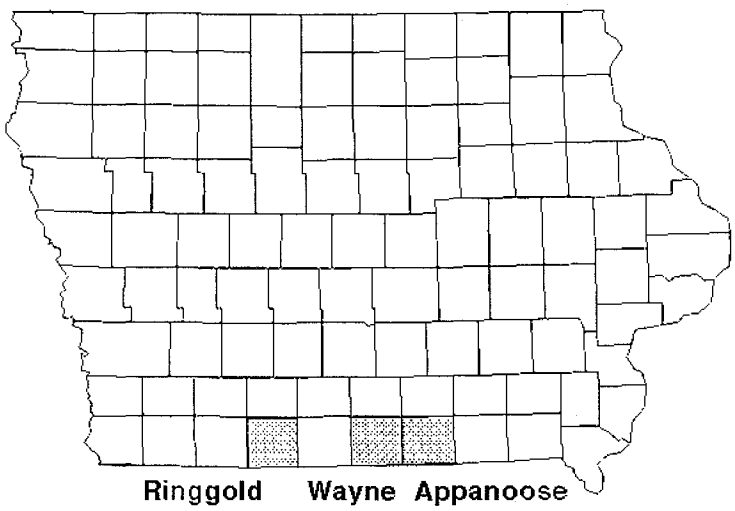
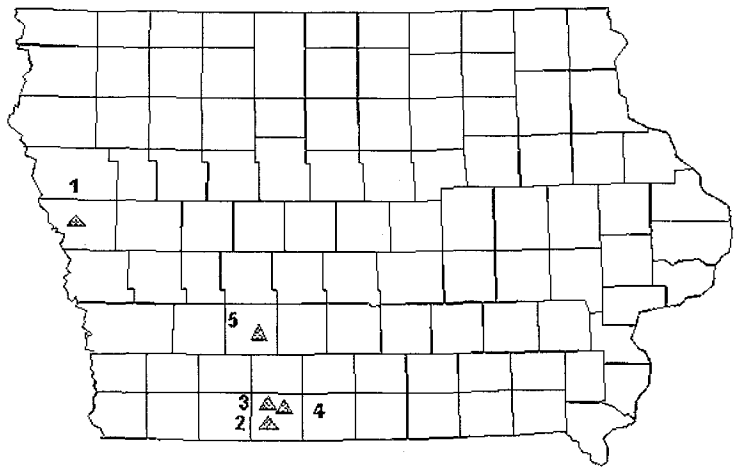


Figure 2. Iowa prairie chicken release sites. 1980-94.



Release site	*Total released*	*Years of release*
1. Loess Hills	*101*	*1980, '82*
2. Ringgold Area	*263*	*1987, '88, '89, '92*
3. Mount Ayr Unit	*39*	*1992*
4. Kellerton	*134*	*1992, '93, '94*
5. Orient	*113*	*1993, '94*

SECOND ATTEMPT

In 1987, a second reintroduction program was initiated by the IADNR on the Ringgold Wildlife Area located 2 miles (3.2 km) north of the Missouri border in Ringgold County in south central Iowa (Site 2, Fig. 2). The IADNR considered this site to be the best potential prairie chicken habitat in Iowa. The immediate vicinity was one of the last strongholds of prairie chickens in southern Iowa and northern Missouri (Christisen 1985, Stempel and Rodgers 1961). The surrounding portions of Ringgold County and adjacent Harrison County, Missouri are cattle country, with 60% or more of the land in permanent grass. Christisen (1985) concluded that the demise of prairie chickens in this area was due to poor quality grasslands resulting from heavy utilization by livestock.

Recent years had brought some positive changes in the grasslands of the area, and it was hoped that these changes would once again provide suitable habitat for prairie chickens. One major change was the intensive restoration of around 500 acres (200 ha) of prairie on the Ringgold Wildlife Area. Other changes were better pasture management by some area farmers, and the Conservation Reserve Program (CRP) which converted thousands of acres of cropland into a diversity of mostly undisturbed grasslands for at least 10 years.

The birds for this reintroduction were also obtained from Kansas. Birds for the first 3 years of this effort were obtained through a 3-way trade in which IADNR supplied the Michigan Department of Natural Resources (MIDNR) with wild turkeys while the MIDNR negotiated with the KSDWP to allow a Michigan crew to trap prairie chickens in Kansas for translocation to Iowa.

Prairie chickens were captured in the spring with funnel traps set on booming grounds in the Flint Hills region of Kansas. Every few days captured birds were transported to Iowa and released the next morning utilizing a soft release box and artificial lek technique which had been successfully used in Kansas to reintroduce sharp-tailed grouse (Rodgers 1983).

A total of 254 prairie chickens were translocated to the Ringgold Wildlife Area from Kansas during the years 1987, 1988, and 1989. By the spring of 1988, booming grounds had been established at the original release site and a site 9.4 miles (15 km) south in Missouri. The Missouri site, located on the Dunn Ranch, is a cattle ranch operated by Forrest and Maury Meadows of Bethany, Missouri. In addition to several hundred acres of cool-season pasture, the ranch includes about 1235 acres (500 ha) of well-managed native prairie pasture. The entire ranch has a very open landscape. Before the disappearance of prairie chickens from this location in the 1960s, the ranch had a major booming ground. The booming ground established in 1988 was on the same site as the historic lek, and visible leg bands verified that birds were from the Iowa releases (Maury Meadows, personal communication).

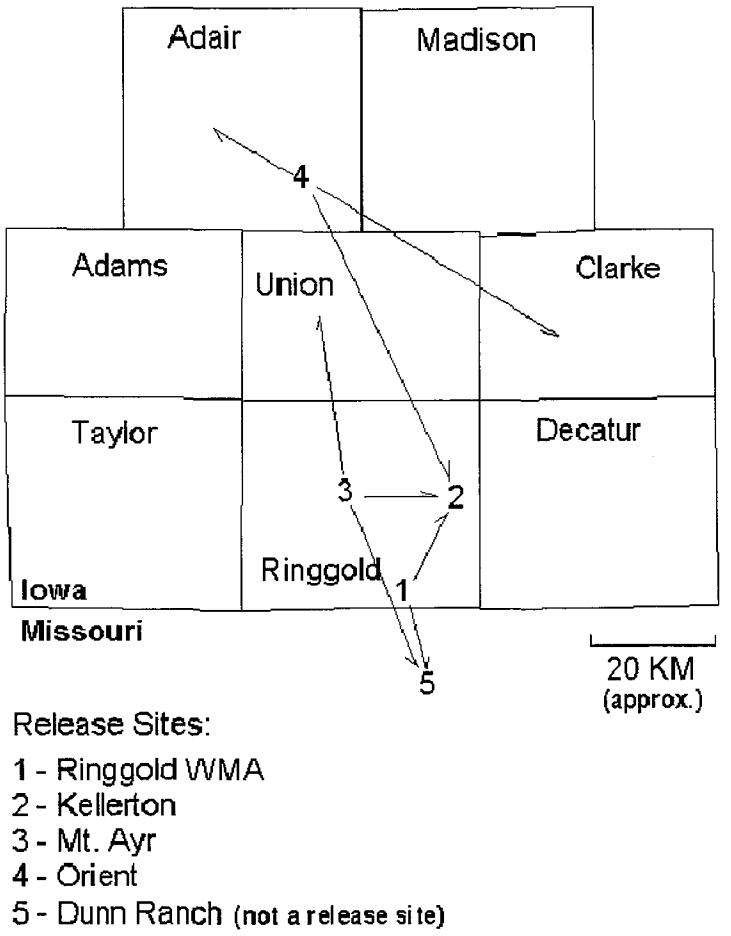
No prairie chickens were released in 1990 or 1991. This was a period of poor reproductive conditions for gallinaceous birds in the area, but brood sightings were made each year. By 1991, prairie chickens appeared to be firmly established on the Dunn Ranch, but only 1 booming ground of 6 males could be located in Iowa that year. The success of the reintroduction of prairie chickens on the Dunn Ranch has been the bright spot of the project thus far. Based on this success, the IADNR continued the program with more Kansas birds. An agreement with KSDWP allowed IADNR crews to trap and translocate 100 prairie chickens per year. Instead of releasing all of the birds at 1 site, it was decided to release significant numbers on large grassland tracts in the region and smaller numbers at the original Ringgold Wildlife Area.

Birds were translocated to 2 new sites in 1992; the Mount Ayr site located 17.5 miles (28 km) northwest and the Kellerton site, 15 miles (24 km) northeast of the Ringgold Wildlife Area. In 1993, the Mount Ayr site was dropped, and the Orient site, located 56 miles (90 km) northwest of the Ringgold Wildlife Area was added. All of the sites contained high quality grasslands and open landscapes. Land use at all 3 sites was mostly a mixture of pasture, hay, and CRP. A total of 295 prairie chickens were released in a 3-year period using gentle releases onto artificial or actual leks. Since 1987, a total of 549 prairie chickens were released at 4 sites in southern Iowa (Fig. 2).

MOVEMENTS FOLLOWING RELEASE

All of the translocated prairie chickens were banded and 14 birds were equipped with radio collars to obtain movement information (Fig. 3). Noteworthy is the apparent ability of prairie chickens to find distant booming grounds. Birds from all release sites visited the vicinity of the Kellerton release site. This in-

Figure 3. Last known radio locations or band returns of prairie chickens that were more than 6.25 miles (10 km) from their original release site.

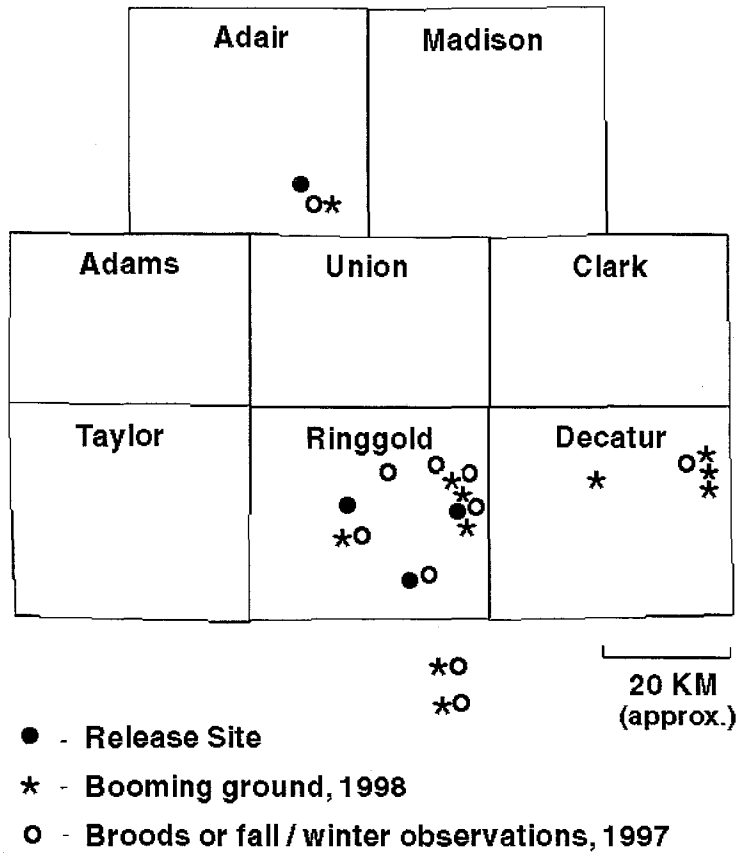


cluded 1 radioed bird released at Orient that traveled at least 50 miles (80 km) to reach the Kellerton site.

MISSOURI REINTRODUCTIONS

The Missouri Department of Conservation (MDC) has been involved in a prairie chicken reintroduction effort in north central Missouri since 1993. They have released birds at 8 sites located 37.5–62.5 miles (60–100 km) southeast of the Ringgold Wildlife Area, and 6.3–25 miles (10–40 km) south of the Iowa border (Larry Mechlin, MDC, personal communication). Prairie chickens were sighted immediately south of the Iowa border in the spring of 1998 and it is probable that adjacent areas in Iowa have prairie chickens as a direct result of Missouri's stocking efforts.

Figure 4. Known prairie chicken locations, summer 1997–spring 1988, in relation to release sites.



Results of Reintroductions

CENSUSING

Attempts are made to locate leks and count booming males each spring by IADNR personnel and volunteers. Because of the large area of potential habitat and the limited manpower available for censusing, the number of booming males observed is considered minimal. It is highly probable that a number of booming grounds have not been located. MDC personnel make similar counts on and around the Dunn Ranch, where the birds are part of the same regional population.

Iowa – In the spring of 1995, 1 year following the last Iowa release, 40 male prairie chickens were observed on 7 booming grounds. Nesting conditions were only fair that spring, and in 1996 the numbers dropped to 26 males on 6 booming grounds. Regionally, in 1996, upland bird nesting conditions were the poorest in recent memory. Consequently, 1997 counts reflected these conditions with only 17 males recorded on 4 booming grounds. Upland bird nesting conditions improved in 1997 and 42 males were observed on 8 booming grounds in the spring of 1998.

Missouri—Trends were similar at the Dunn Ranch in Missouri. Counts dropped from 35 males in 1995, to 22 in 1996 and 23 in 1997, but rebounded to 46 in 1998 (Bill Lenhart, MDC, personal communication).

Sightings and known booming grounds for the winter of 1997–98 and the spring of 1998 are presented in Figure 4. Iowa sites are indicated as well as those in Missouri believed to be associated with the Iowa releases.

Discussion

The prairie chicken reintroduction efforts initiated in Iowa in 1987 and in Missouri in 1993 have resulted in a small, but somewhat stable population of prairie chickens across a wide area of southern Iowa and northern Missouri. Large amounts of habitat in this area still lack

prairie chickens and additional stocking would help fill in the gaps and augment existing local populations. Proposed stockings in Iowa include releasing additional hens onto all known booming grounds, and establishing new release sites in suitable habitat.

Pasture and hay are still primary land uses in this region and, coupled with a recent high CRP sign-up, should assure adequate grassland habitat for the next 10 years. A positive aspect of the recent CRP guidelines was the emphasis on establishing cover beneficial to wildlife instead of grass monocultures. The Wildlife Habitat Incentives Program (WHIP) of the USDA also targets improvement of prairie chicken habitat in south central Iowa and should benefit prairie chicken populations.

Intensive management of large blocks of grassland by public agencies will help ensure adequate habitat into the future. To help provide this habitat for prairie chickens and other grassland birds, Iowa has initiated the Kellerton Bird Conservation Area (KBCA). This is a proposed 10,300 acres (4,170 ha) area that presently consists of 70% grassland, 25% cropland, and 5% woodland, and had at least 3 booming grounds in 1998. The KBCA proposal calls for public acquisition of at least 2,050 acres (830 ha) of the area and working with landowners to improve habitat on at least 2,470 acres (1,000 ha) utilizing the CRP and WHIP program lands. This program has been given a high priority through the Partners in Flight-Midwest Steering Committee, and funding for initial acquisition has been provided by the IADNR, the National Fish and Wildlife Foundation, and numerous private donations including funds from Pheasants Forever and the Iowa Audubon Society. Lands acquired will be managed by the IADNR. The IADNR has recently acquired more property on the Ringgold Wildlife Area, bringing the total size to 1,853 acres (750 ha) of which 741 acres (300 ha) is managed as grasslands with open landscapes. Though no booming grounds have been located on this area in recent years, broods have been sighted nearly every summer.

The MDC and The Nature Conservancy have each acquired several hundred acres of grassland between the Ringgold Wildlife Area and the Dunn Ranch, and this land will be managed for grassland species (Bill Lenhart, MDC, personal communication).

The aggressively managed public tracts surrounded by large areas of less intensively managed private grasslands should assure prairie chicken habitat into the future.

Acknowledgments

The Federal Aid in Wildlife Restoration Project FW-43-D and the IADNR provided funding for this project. The cooperative effort of the MIDNR and the KSDWP, as well as numerous farmers and ranchers in Iowa and Kansas made this project possible. A special thanks to participating personnel of the IADNR and KSDWP, especially the technicians, whose hard work over 10 years got the job done. Thanks also, to the Adair County Conservation Board and numerous volunteers.

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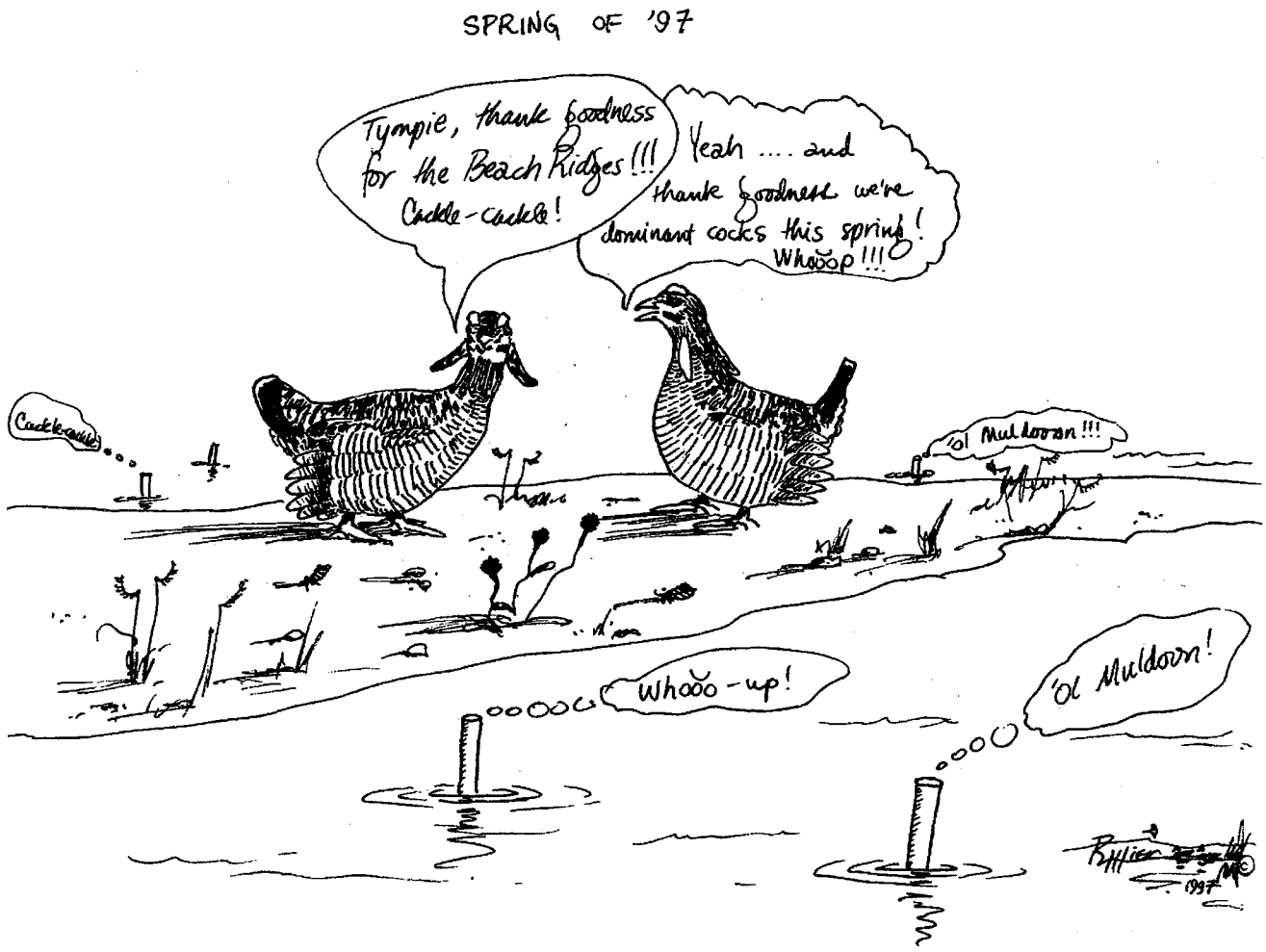
SPRING OF '97
Tympie, thank Goodness for the Beach Ridges!!! Cackle-cackle!
Yeah .... and thank Goodness we're dominant cocks this spring! Whoooop!!!
Cackle-cackle!
'ol Muldoon!!!
Whooo-up!
'ol Muldoon!
1997

Status and Management of Greater Prairie Chickens in Missouri [1]

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Historical Review

Before the 20th century, prairie chickens probably occurred in every county of Missouri with native prairie. Schroeder's (1981) analysis of land-survey records indicated 26.7% (18,474 square miles [48,032 km^2]) of the state was originally native prairie (Fig. 1). Others believed approximately 40% was prairie (Bennitt 1939, Christisen 1973). Differences in these estimates were reconciled by including small, scattered prairies. Surveyors did not include "barrens," the grassy Ozark tracts, as prairies. "Glades," very small, usually steep Ozark hillside forest openings, were excluded as were some prairies with trees in draws, scattered small groves, and thickets (Schroeder 1981). Apparently, periodic wildfires kept Missouri's native prairies from being lost to tree and shrub invaders (Christisen 1967).

Prairie chickens probably occurred wherever prairie existed in contiguous tracts of a few thousand acres, intermingled with less than 10% woodland. Prairie chickens not only occupied the great prairies of northern and western Missouri, but also the smaller grasslands of the Ozarks, according to historians.

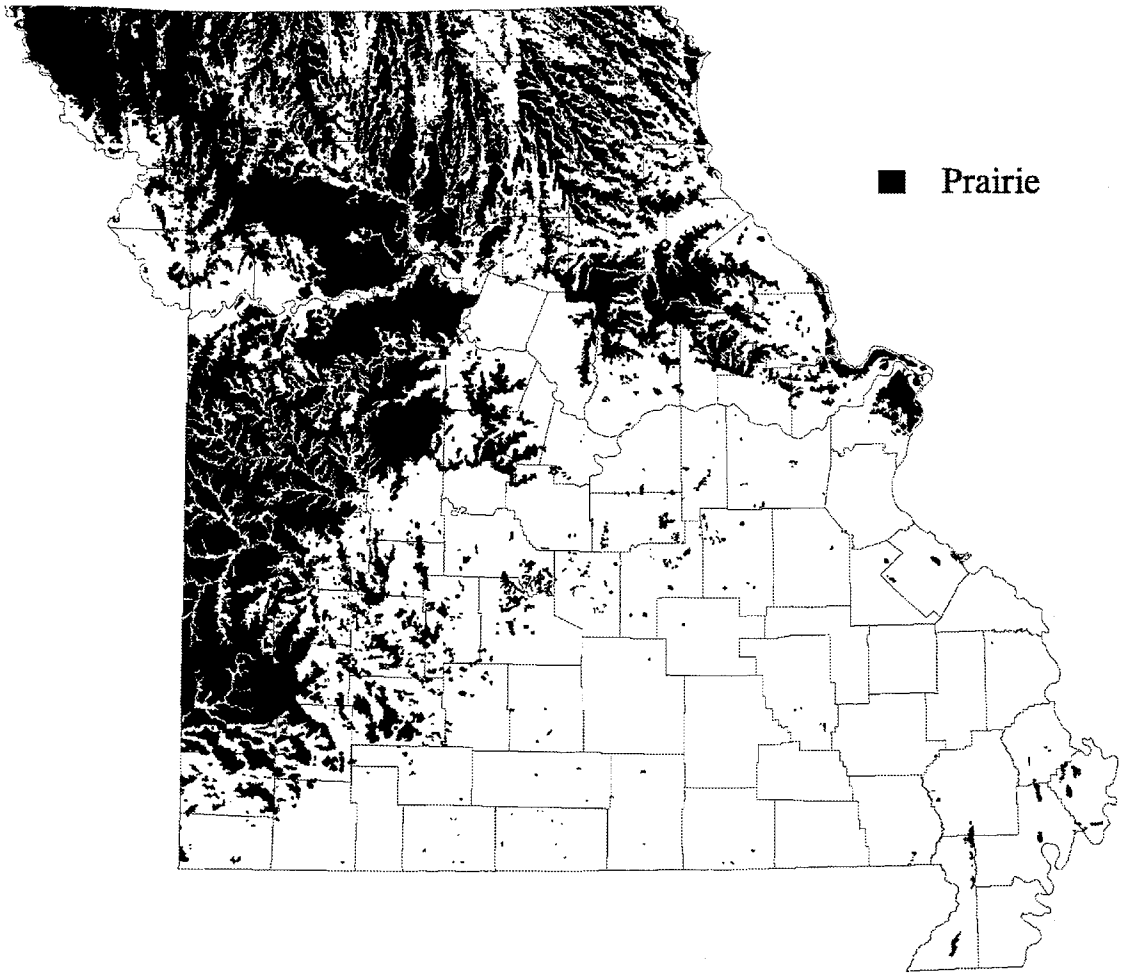
Prairie chickens were reported in Gasconade, Iron, Perry, and St. Francois counties in the eastern Ozarks and in the central Ozark counties of Howell, Reynolds, Ripley and Shannon (Leopold 1931). Early records indicated 14 of 24 Ozark counties had prairie chickens (Bennitt and Nagel 1937). Prairie chickens have been observed in Camden, Miller and Taney counties, at one time or another, from 1975 to 1985 and in Maries County earlier.

It is of interest that Schroeder (1981) stated "prairies occupied 38 square miles (99 km^2) or 61% of St. Louis City and 86 square miles (224 km^2) or 17% of St. Louis County" before settlement. Undoubtedly, this metropolitan area on the banks of the Mississippi River was once occupied by prairie chickens along with its mammalian associate, the bison.

Only remnants of the presettlement prairie remained when the first formal survey of the prairie chicken range was completed (Bennitt and Nagel 1937). The authors considered all of north Missouri, the Western Prairie, and

[1] *A draft of this paper was originally developed by Richard W. Cannon and Donald M. Christisen in March of 1985. That draft is archived with Donald Christisen's papers in the Western Historical Manuscript Collection, 23 Ellis Library, University of MO., Columbia. Larry Mechlin updated that draft to reflect current research findings and change over the past 13 years in the population status and management strategies for prairie chickens.*

Figure 1. Presettlement prairie in Missouri.

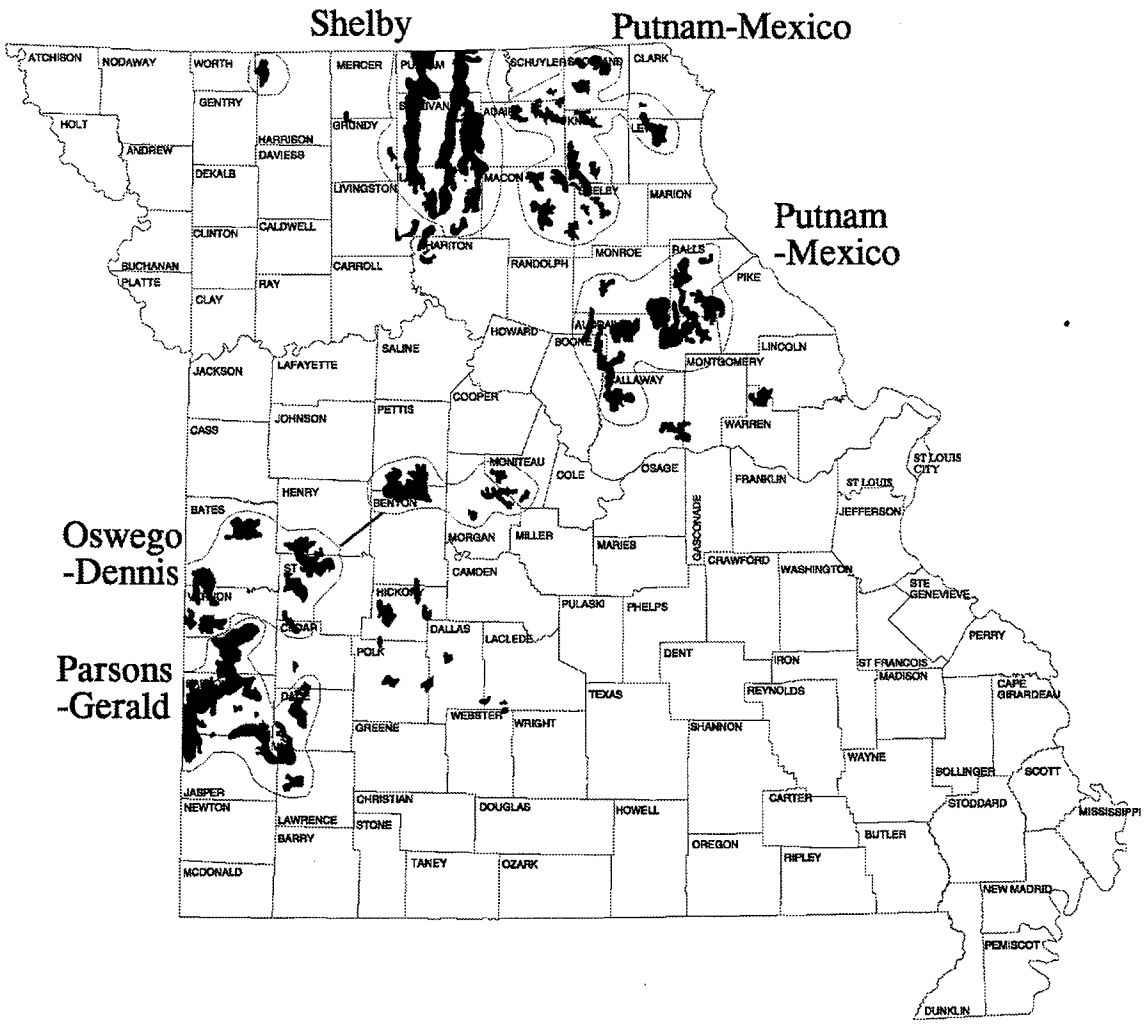


the Ozark Border as range, roughly 40,215 square miles (104,559 km^2), recognizing that only 27,031 square miles (70,281 km^2) were occupied. Bennitt (1939) expressed "little doubt that present agricultural trends in Missouri are increasing and improving the prairie chicken range and are likely to continue to do so." He also believed most of the loss of range occurred before 1900.

A more exhaustive field survey in the early 1940s resulted in a prairie chicken range map of the state on a county basis (Fig. 2 , Schwartz 1945). This map was based largely on soil types, vegetation, and topography, and was refined by field interviews in counties where birds were reported. Time did not permit delineation of prairie chicken range by field surveys in a few instances, but observations of birds were plotted on range maps. This survey represented the most accurate delineation of prairie chicken range for the state until 1983 (Cannon and Christisen 1984b). Figure 3 includes the most recent range update utilizing information from the 1993 range wide survey and annual surveys through 1997. Schwartz's (1945) 2,500 square mile (6,500 km^2) range accounted for only 13.5% of the most conservative estimate of what once was prairie chicken range, the presettlement prairie.

Approximately 88% of the occupied prairie chicken range comprised 8 soil types; 18,759 square miles (48,773 km^2) of these soils were unoccupied by prairie chickens, but were considered potential range (Table 1, Schwartz 1945). Over half the prairie chicken range

Figure 2. Missouri prairie chicken range in 1940 and associated soil types.



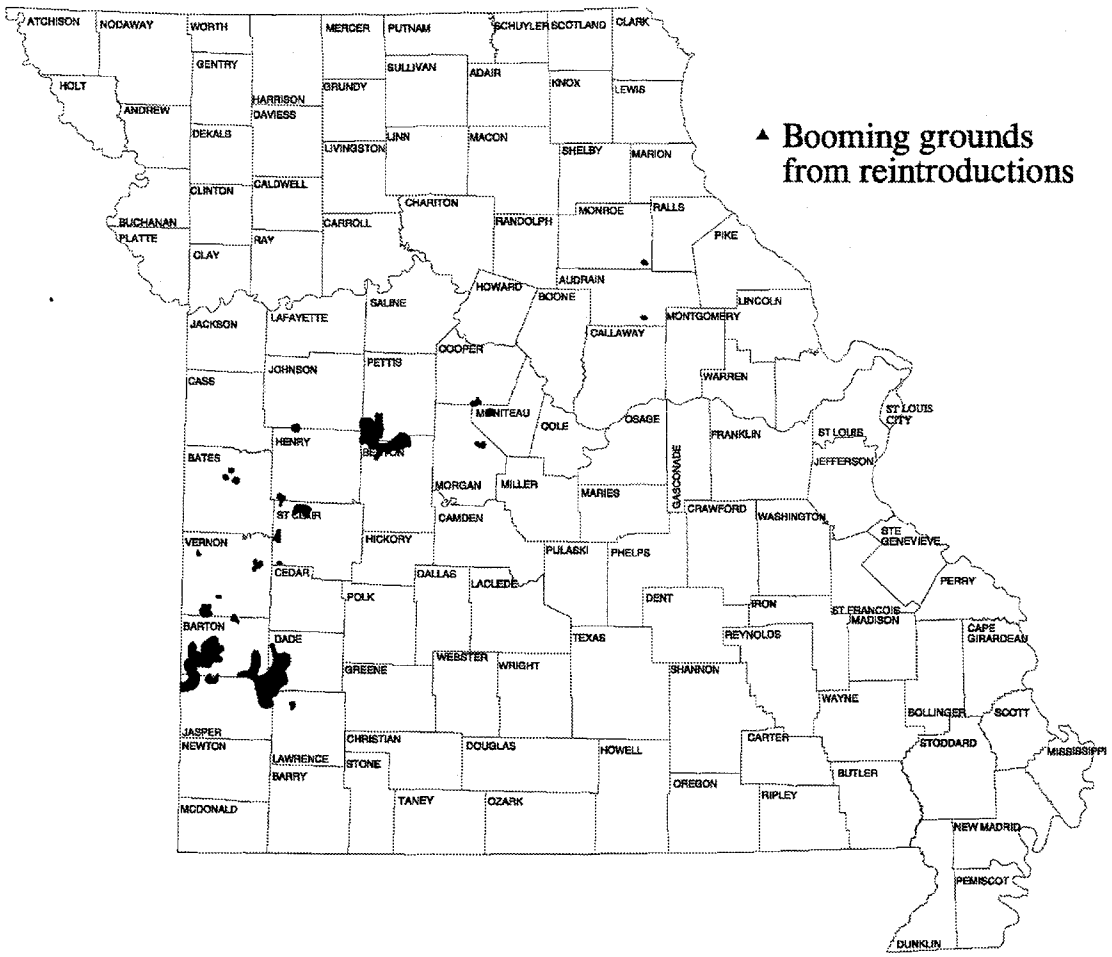
segments were in parcels of 2.8 to 18.7 square miles (7.3 to 48.6 km²) and represented a total of 270 square miles (702 km²) of range. Overall, the size of range segments varied from 2.8 to 383.1 square miles (7.3 to 996.1 km²) (Table 2, Schwartz 1945).

The Schwartz map was considered the basic range of the prairie chicken in Missouri for nearly 40 years. By the mid-1950s, prairie chickens had disappeared from most of the range north of the Missouri River (Christisen 1969). It was estimated that only 900 square miles (2,340 km²) of range remained in south Missouri, in addition to approximately 200 square miles (520 km²) in north Missouri.

A lek survey of south Missouri in 1983 indicated a breeding range of 632 square miles (1,643 km²), comprising 64 segments (Cannon and Christisen 1984b). Size of breeding range segments varied from 3 to 77 square miles (200 km²). The 1998 5-year range update should provide us with new estimates, but probably no more than 400–500 square miles (1,080 to 1300 km²) of range are currently occupied by resident birds.

Early historians cite many stories of settlers proclaiming the great abundance of prairie chickens, along with accounts of market hunters taking thousands of birds (Britton 1929, McKinley 1960). Bennitt (1939) speculated that a population of one million would have meant an average density of only 36 birds per square mile (2.6 km²). Based on the most conservative estimates of prairie habitat and bird density (5 to 10 birds per square mile [2.6

Figure 3. Missouri prairie chicken range in 1997.



km²]), the spring breeding population of prairie chickens was 92,370 to 184,740 birds in a land of few people. Kirsch (1974) writes of a prairie chicken management goal of 100 cocks per square mile (2.6 km²), implying a realistic expectation. When optimum habitat for this bird existed in Missouri, this standard of density may have occurred naturally. Apparently, hundreds of thousands, perhaps even millions of prairie grouse were in Missouri. The peak population likely occurred at the time when 25 to 30% of the prairie was in till crops — possibly in the 1860s, certainly not much later. Prairie chickens were considered abundant until the Civil War, but afterwards gradually disappeared from most of western Missouri (Britton 1929).

The State Game and Fish Warden's Annual Report of 1907 showed an estimate of 12,500 birds based on a 3-county survey sample by Chief Warden, J.H. Rodes. During the 1929–30 winter, Leopold (1931) estimated 8,647 birds in 33 counties with a density of 8.1 birds per square mile (2.6 km²). Another estimate of 10,000 birds was released by the State Game and Fish Warden in 1932. Bennitt and Nagel (1937) estimated 5,110 birds in the resident fall population of 1934 and a breeding population of about half that number. The population was estimated by Bennitt (1939) at 6,630 birds in the spring of 1938 and 13,000 in the spring of 1940 (Bennitt 1940). The Schwartz (1945) field study, utilizing farmer interviews and a lek census sampling of the range in 1941–44, set the number of prairie chickens at well above 13,000. Christisen (1970) estimated a population of 7,000 prairie chickens

Table 1. Missouri prairie chicken range according to soil types, 1942. [1]

Soil type	Square miles in Missouri	Occupied by prairie chickens		Prairie chickens per square mile	Square miles unoccupied
		%	Square miles		
Putnam silt loam	3,258	12	396.0	3.2	2,862.0
Grundy-like	504	39	195.3	3.9	308.7
Shelby loam	4,608	13	617.8	6.6	3,990.2
Summit silt loam	1,744	7	129.8	4.9	1,614.2
Oswego silt loam	3,362	8	276.5	6.4	3,085.5
Cherokee silt loam	1,555	30	467.9	3.4	1,087.1
Lebanon silt loam	1,905	2	38.1	2.6	1,866.9
Wabash & Grundy silt loam	4,025	2	80.5	6.8	3,944.5
Total	20,961*	10.5	2,201.9	5.4	18,759.1

[1] *Adapted from Schwartz (1945).*
** Miscellaneous portions of other soils comprise balance of 2,500 square miles of range.*

for south Missouri in 1965 with another 500 in north Missouri.

Schwartz (1945) estimated the prairie chicken population of Missouri's 2,500 square miles (6,500 km^2) of remaining range to be 13,992 (adjusted) in 1942, 12,413 in 1943 and 9,250 in 1944. To afford a comparison with most recent estimates, sex ratios listed by Schwartz were used to reduce his population to cocks; 8,135 in 1942; 8,008 in 1943; and 6,801 in 1944. The estimated population of cocks in 1982 for 900 square miles (2,340 km^2) of range was 5,657, and a few cocks (<100) in north Missouri (Christisen 1982). It appears that despite a loss of about 56% (1,400 square miles [3.640 km^2]) of range, the number of cocks declined no more than 30%. Today (1998), the population of resident birds is estimated at 1,000 birds. Nearly the entire population resides in southwest Missouri and is represented by routes run in that region. Survey results indicate that population has been in decline for the last 28 years (Fig. 4).

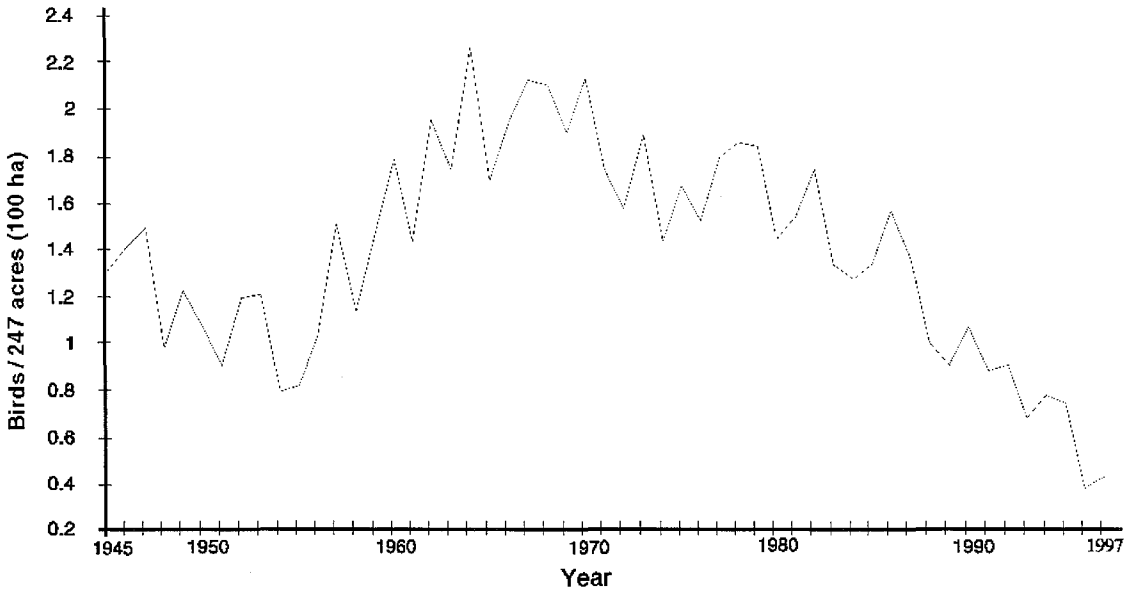
In the early 1940s, the largest and most densely populated prairie chicken ranges were in north Missouri in an area that extended from the Iowa line south through Putnum, Sullivan and into Linn counties (Schwartz 1945). This population went from an already declining population of 3,100 birds in 1941 to near zero by the mid-1950s. A combination of

Table 2. Size classes of Missouri prairie chicken range. [1]

Range size in square miles	Number of ranges	Percent of total range	Square miles occupied
2.8–18.7	26	50.9	270.1
22.5–55.5	16	31.3	595.0
72.7–84.4	5	9.6	390.4
173.0–383.1	4	7.8	946.4

[1] *Adapted from Schwartz (1945).*

Figure 4. Missouri prairie chicken trends south of the Missouri River.



factors made the decline in north Missouri so dramatic. Habitat destruction certainly played a role with the intensification of agriculture following World War II. Attempts were made to reintroduce populations in Macon (1965, 1966), Chariton (1971, 1973) and Harrison (1973) counties, but they were not successful. These releases involved small numbers of birds and were conducted without the benefit of telemetry for evaluation.

In recent years, grassland habitat has improved greatly in the north Missouri historic prairie chicken range including Sullivan, Putnam, Harrison, and Mercer counties. Many cultivated fields from the 1980s have been returned to pastures and haylands, alongside a substantial increase in acreage of rested grasslands resulting from the Conservation Reserve Program (CRP). Sullivan and Harrison were among the counties with Missouri's highest CRP enrollment. Habitat improvement, availability of 11-gm necklace transmitters (McKee et al. 1997) to aid with evaluation, and recent successes by Iowa with reintroductions that resulted in the reoccupation of a historic booming ground in Harrison County, Missouri, provided the support needed to attempt reintroductions again in Missouri.

Recent Translocations

One hundred birds, trapped in Kansas, were released in Sullivan County in April of 1993 and 1994. Some birds were highly mobile in 1993 with 2 hens nesting 31 and 21 miles (49.7 and 33.6 km) from their release site. In 1994, 2 hens nested approximately 25 miles (40 km) while 4 others nested 15 miles (24 km) from their respective release sites. In the spring of 1995, 4 booming grounds in Sullivan County had 10, 12, 16, and 20 males displaying on them regularly. Additional releases were made in April of 1996 and 1997 with birds trapped in Nebraska. One hundred birds were released each of these years at several release sites in Mercer, Putnam and Sullivan counties. Reports of flocks of birds are being investigated during the 5-year range-wide survey this spring and we are hopeful more new booming grounds will be located.

Census Procedures

The lek census sampling of about 18% of the prairie chicken range initiated by Schwartz has been conducted annually since 1945, with some modifications in 1961. The loss of

birds from most of north Missouri prompted census discontinuation on some routes, as well as changes in the configuration of other routes for south Missouri. Since 1975, the lek census has been expanded to include public prairies (Toney 1981).

Only wildlife biologists and managers conducted the lek census after 1955, and birds on each lek were sexed after 1961. Traditionally, with untrained personnel, the census had been conducted during the third week of April, when most birds on the lek sites were males. Beginning in 1962, the census period was set earlier and expanded from late March to mid-April. The earlier population figures from 1946–62 were converted to cock populations, but estimates beginning in 1962 probably are more reliable (Table 3). For a representation of long-term population trends in south Missouri, where sexes were not always determined and where annually run survey routes experienced some change in length, all birds seen are included and displayed on a per area basis in Figure 4.

Harvest

The season on prairie chickens has been closed since 1907 (Bennitt and Nagel 1937) and has remained closed to the present. *The Species Management Plan for the Greater Prairie Chicken* (Cannon and Christisen 1984a) included a final objective to determine the feasibility of a limited harvest. Since the statewide population has continued to decline, this objective was not included in the current species management plan (Mechlin 1991) and will most likely not be included in the revision of the plan to occur in 1998–99. If regional populations develop to the point where they could support harvest, donor populations of prairie chickens will be considered for translocation to unoccupied habitat.

Public Needs

The prairie chicken enjoys a wide range of support from Missouri's citizens for several reasons. Since the prairie chicken was once an upland game bird in the state, and continues to be hunted in neighboring Kansas and Nebraska, it is of interest to upland bird hunters and bird dog enthusiasts. It is also of interest to the public because historically, during the white settlement period, chickens were often noted due to their abundance, their role as a food item, and their interesting spring displays. Their past influence on Native American dance attracts further support.

Among the more environmentally aware it serves as a symbol of the diminished prairie community within the state. Since 1966, the Missouri Prairie Foundation (MPF) has promoted prairie preservation through awareness and land acquisition. The MPF has long used the prairie chicken as a natural symbol of a movement to preserve what little prairie remains. The 1990 Crossroads Conference, organized by the MPF, focused further attention to the current perilous status of prairie chicken and the prairie community overall. They are currently involved in the formation of a coalition of public and private agencies to address habitat problems for all grassland birds using the prairie chicken as a focal point. The prairie chicken is currently rated as *endangered* in Missouri making it of primary interest to many.

The interesting and colorful breeding displays of the prairie chicken create more support for the bird than any other factor among the public. The problem has been handling the demand without jeopardizing the resource. The Missouri Department of Conservation stationed seasonal blinds at a lek site on Taberville Prairie (Toney 1981), St. Clair County, for use by the public. Without supervision, however, within several years the harassment to the birds was sufficient to cause the booming ground to be vacated. Currently, after some words of caution, interested parties are sent to sites where they can view booming grounds from their vehicles along the roadside. Viewing opportunities exist at Prairie State Park, where staff is on-site, and at a privately run bed and breakfast establishment.

The current species management plan (Mechlin 1991) calls for the development of more viewing opportunities, but this will be contin-

Table 3. Estimated Missouri cock prairie chicken population by year and soil type.

Year	% of range censused	South Missouri (900 mi.²)	Males per mi.² range	Oswego (276.5 mi.²)	Summit (129.8 mi.²)	Cherokee (467.9 mi.²)	Grundy-like (195.3 mi.²)	Shelby (617.8 mi.²)	Putnam (396.0 mi.²)	State (2,500 mi.²)
1945		3,748	4.16	1,641	656	912	325	2,078	418	6,941
1946	19.0*	3,338	3.71	1,237	799	1,042	307	668	338	5,860
1947	15.9*	3,186	3.54	1,262	683	907	229	695	415	5,955
1948	7.3*	2,741	3.05	639	998	958	262	770	250	4,770
1949	10.6*	3,222	3.58	891	1,088	1,298	138	429	161	4,974
1950	8.7*	3,158	3.51	755	919	1,638	0	523	216	5,661
1951	10.2*	2,586	2.87	633	928	1,211	152	837	127	4,949
1952	11.8*	3,120	3.47	849	779	1,451	87	657	303	5,160
1953	12.1*	2,978	3.31	800	751	1,488	114	305	233	5,374
1954	12.9*	1,891	2.10	375	178	1,607	17	20	186	3,095
1955	21.2	1,778	1.98	401	465	1,123	—	—	—	—
1956	14.2*	2,311	2.57	543	150	1,890	—	64	78	3,624
1957	20.2	3,127	3.47	698	178	2,875	—	—	—	—
1958	13.1*	2,195	2.44	495	430	1,612	—	0	16	3,412
1959	20.5	3,039	3.38	673	509	2,291				
1960	20.5	3,998	4.44	762	180	3,742				
1961	19.8	3,754	4.17	686	261	3,444				
1962	21.6	4,530	5.03	868	334	3,779				
1963	24.5	3,748	4.16	573	419	3,474				
1964	24.5	4,457	4.95	776	276	3,995				
1965	21.5	3,591	3.99	754	275	2,807				
1966	18.8	5,150	5.72	1,777	297	3,006				
1967	18.8	5,920	6.58	1,352	216	338				
1968	18.8	5,315	5.91	1,376	311	3,685				
1969	18.8	4,837	5.37	1,389	239	3,234				
1970	18.8	5,310	5.90	1,403	176	3,819				
1971	18.8	4,216	4.68	1,266	—	3,018				
1972	18.8	4,173	4.64	1,216	86	2,924				
1973	18.8	4,949	5.50	1,335	90	3,620				
1974	18.8	3,462	3.85	1,107	108	2,252				
1975	18.8	4,099	4.55	1,207	189	2,720				
1976	18.8	3,897	4.33	1,312	176	2,380				
1977	18.8	4,248	4.72	1,485	122	2,614				
1978	18.8	4,635	5.15	1,622	104	2,889				
1979	18.8	4,827	5.36	1,749	99	2,942				
1980	10.1	6,453	7.17	2,660	—	2,472				
1981	18.3	4,098	4.55	1,058	50	2,492				
1982	14.3	5,657	6.29	1,431	—	3,258				

* *For the state*

Lebanon, a south Missouri soil type, included 38.1 mi.² of prairie chicken range and had the following cock populations — 1945, 25; 1946, 144; 1947, 119.

Wabash, a north Missouri soil type, included 80.5 mi.² of prairie chicken range and had the following cock populations — 1945, 141; 1947, 98; 1949, 152.

gent upon securing the labor and regulations to protect the integrity of the leks being observed. Past disturbance problems have been from overzealous photographers and from viewers moving out of blinds to investigate prairie wildflowers near booming grounds.

Species Needs

The major limitation for prairie chickens, recognized since 1937, has been one of habitat deficiency, specifically the quantity and quality of permanent grass. Any food deficiencies have been local and short-term.

Christisen's (1985) land-use study of former and current prairie chicken range documented not only the shortage of permanent grass in relation to grain crops but also the lack of diversity in the kinds of forage crops grown. The survey revealed that an extensive portion of the range in north Missouri (Shelby soils, Table 3) had an ideal ratio of permanent grass to crops, yet supported no breeding populations of prairie chickens. Christisen (1985) reported 60% of the Shelby range in pasture. Apparently, the necessary vegetative structure within grasslands was not present to provide quality nesting and brood rearing cover. This deficiency could be corrected with different management or grass species, but it would be difficult because economics dictate what crops are grown on private land.

Better forage crop management is required to allow greater height of grass cover for nesting and roosting. Most of northern Missouri pastureland is in cool-season grasses. Those grasses include orchard grass (*Dactylis glomerata*), timothy (*Phleum pratense*), and smooth brome (*Bromus inermis*) that when managed properly, especially in a mixture with a legume, can provide excellent nesting, brood-rearing and roosting habitat. Unfortunately, tall fescue (*Festuca elatior*) is the most common cool-season grass and it seems to encourage overuse and abuse by managers. This occurs for 2 reasons. Tall fescue is resilient to abuse, maintaining itself in stands even though continuously overgrazed and because of endophyte fungus problems that occurs in more mature vegetation of this species. Currently 60% of the Shelby range is in pasture. Kirsch (1974) concluded that annual grazing is undesirable for prairie chickens. However, in the tallgrass prairie region of Missouri, cattle grazing at some level is attractive to prairie chickens. "Light to moderately grazed prairie pasture was used more frequently than any other cover type for all activities except feeding" was reported by Drobney and Sparrowe (1977) after evaluating 7,160 observations of cocks in the Mora locality of Benton County, Missouri. When looking at 21 species of grassland birds, Skinner et al. (1984) found grazing to be the most versatile management practice among grazing, fire, haying, and rest. When stocking rates were adjusted, all cover conditions could be provided.

Another portion of the north Missouri range (Putnam-Mexico soils, Christisen (1985) has insufficient permanent grass cover to support anything better than a marginal population of prairie chickens. Owing to the soil fertility and the price advantage of grain over forage production, no change in this situation is likely. In addition, this highly productive, non-erosive land is not likely to qualify or be a good choice economically for farmers to enroll in the current CRP. Wheat could be a redeeming feature, compensating for the deficiency of permanent grass since it is used for nesting (Skinner 1974, Jones 1988). The stubble, with a mix of annual weeds that emerge after the wheat matures, can provide quality brood and roosting cover. Unfortunately, the increase in double cropping of wheat with soybeans has become a common practice here and in southwest Missouri (Oswego-Dennis and Parsons-Gerald soils) where the bulk of the population now resides.

Audrain County is the home for the few remaining chickens existing on Putnam-Mexico soils. Approximately 6,000 acres (2,400 ha) in Audrain County of wheat were double cropped in 1996. Double cropping results in early harvest of the wheat, burning or tilling of the stubble and planting to beans, leaving little for prairie chickens. Single crop wheat fields that are usually tilled in the fall provide no benefits as roosting or escape cover (Skinner 1974, Christisen 1981a).

The southwest portion of the prairie chicken range has an adequate amount of permanent grass but lacks diversity because tall fescue, grown to the exclusion of other grasses, is the major forage crop. In the absence of other preferred grasses better suited structurally for nesting and roosting (Christisen and Krohn 1980), fescue can support a density of about 5 prairie chickens per square mile (2.6 km^2). A conversion to diverse native warm-season, or non-fescue diverse cool-season pastures and haylands, would greatly improve habitat for prairie chickens in this region. Higher prairie chicken population densities are related to diversity of grass species and presence of prairie grass over fescue (Christisen and Krohn 1980). Native prairie is still a dominant and beneficial component of south Missouri prairie chicken habitat because of the great variety of plants and diversity of cover heights it provides (Christisen 1981b).

Management Needs

The most important management needs for prairie chicken populations within the state have remained constant through 2 species management plans beginning in 1983, and they undoubtably will be a major focus within the plan to be updated in 1998. The creation of grassland habitat through land acquisition and management, an aggressive private-lands program, and the reintroduction of birds to available habitat in north Missouri are our most important management needs.

There is very little margin for error in the preservation of prairie chickens in Missouri. The fragmented, but still extensive, breeding range mapped by Schwartz (1945) simply vanished in north Missouri within 10 years after his survey (Christisen 1981b). The nearly complete extirpation of prairie chickens in north Missouri resulted from a dramatic and unexpected change in crop and grassland management (Christisen 1985). Today, in south Missouri, a similar disadvantage exists in predicting the future of prairie chickens because cropping and grassland management practices are dictated by economics of the marketplace.

Land Acquisition

The strategy for land acquisition has changed. Due both to an intensification of agriculture and to woody encroachment, the grassland landscape no longer exists. The acquisition of small, high quality scattered tracts of grassland results in isolated pockets of habitat not large enough to be self-sustaining and too disconnected to maintain populations within a region. In 1991, the land acquisition strategy became one of creating core areas of grassland of at least 2 square miles (5.2 km^2) surrounded by additional scattered tracts of grassland. This strategy is supported by research findings from Burger (1988) and Jones (1988) in their comparison of survival, movement, reproduction, and habitat use by prairie chickens inhabiting an isolated large block of native prairie with a population occupying a "scatter-pattern" (Hamerstrom et al. 1957) of habitats.

The melding of the 2 popular habitat acquisition strategies seemed to provide greater protection to the population. Within the large core, fragmentation and its negative affects should be reduced, birds required to move less to meet needs should experience reduced exposure to predation, and fewer losses due to agricultural machinery. Scattered adjoining tracts could provide areas for expansion under good environmental conditions, opportunities for genetic mixing and protection for the population against localized random events such as a major hailstorm. These population centers, made of core areas and associated smaller tracts, were to be created through acquisition and an aggressive private lands program. Though development of these areas has been painfully slow, indications are that this habitat acquisition will be carried forward.

Private Lands Programs

The best remaining Missouri populations exist on scattered tracts of privately owned prairie. However, the future of these populations is in doubt as prairie loss persists due to continued row cropping. Approximately 75,000 acres

(30,000 ha) of native prairie remains, most of which occurs within the breeding range of the prairie chicken (Christisen 1973). Greater than 80% of the remaining flocks of prairie chickens in Missouri occur in areas with significant native prairie acreage. Therefore the restoration, if not the survival, of prairie chickens within the best portions of the remaining range hinges on the preservation and proper management of native prairie tracts. In addition, the establishment of diverse warm-season native or cool-season grasses, other than fescue, adjacent to these native tracts could provide additional habitat and reduce fragmentation.

Because 97% of the prairie chicken breeding range is privately owned, there is a need to provide landowner services. A range-wide effort continues with private landowners. However, beginning in 1993, an aggressive 10-year program, "Partners for Prairie Wildlife," began which targeted a limited portion of the range. Specific cost share incentives were developed for 2 areas, each 40 square miles (104 km^2) with a complement of public and private prairie tracts and some of the better chicken populations statewide.

This experimental program addressed the problem that habitat improvement, resulting from range wide programs, are so diluted by wide spacing that they provide little for true grassland species such as prairie chickens. Partners for Prairie Wildlife addresses tree removal to reduce fragmentation and the establishment of permanent and temporary grasslands. It contains programs for fescue conversion and over-seeding of wheat. The greatest change to the approach of this private-lands initiative is that it is proactive. Adjacent lands that through a change in management could provide complementary habitat for prairie chickens are identified. The owners of those lands are then contacted to explore possible cooperative efforts beneficial to both parties. For example, the practice of over-seeding lespedeza onto wheat stubble can provide brood-rearing habitat next to existing nesting habitat. Partners for Prairie Wildlife can provide seed and the landowner can harvest forage or seed in the fall and both parties benefit.

Translocation in North Missouri

Many CRP contracts from the original sign-ups are coming to a close and grasslands created by the program are being put back into cultivation. This is especially true in CRP fields less prone to erosion and/or very productive for crops. Many of these are found in the prairie chicken range of south central and southwest Missouri. However, in Missouri's most northern counties, such as Harrison and Sullivan, CRP grasslands within the chicken range are being maintained. These counties were among the highest in the state for acreage put into CRP and, with the recent sign-up, the acreage has remained very high. The additional incentives to CRP landowners to manage these grasslands are expected to further increase the quality of these previously rested grasslands. Radio telemetry studies of birds relocated to Sullivan, Putnam and Mercer counties in north Missouri recorded nesting in hay fields and CRP grasslands mowed the previous year. Mowed CRP grasslands provided similar vegetative structure to hay fields.

Four stable booming grounds have been formed in Sullivan County from spring releases that took place between 1993 and 1997 and 1 in Harrison County from releases in southern Iowa in the late 1980s. Additional small grounds have been found and others are expected to exist. Additional releases over the next 5 years are needed to continue to build the population forming across northern Missouri and southern Iowa. Prairie chickens released and monitored have been highly mobile and adept at finding other birds. Birds from supplementary releases are expected to create additional leks and supplement others.

Research Needs

The prairie chicken restoration and management program in Missouri will be based on the following research activities: (1) monitor annual population trends and (2) identify and describe habitat elements required to support populations inhabiting altered, contemporary landscapes.

We will continue to monitor populations with annual lek surveys on designated routes and Missouri Department of Conservation Areas and conduct surveys of the entire range every 5 years. The investigation of habitat elements has been part of the research conducted by 3 recent Masters' degree studies and 1 Ph.D. study. Burger (1988) and Jones (1988) investigated differences in survival, movement, reproduction, and habitat use by prairie chickens inhabiting an isolated block of native prairie with a population occupying a scatter pattern of habitats. McKee (1995) investigated vegetative structure and found nest sites with litter cover >25% had a failure rate twice that of nests with <25% litter cover. Nest success declined substantially when woody cover >5% was present at the nests, when forb cover was ≤5%, or when grass cover was ≤25%. Winter (1998) investigated how factors on 3 scales (within patch, local scale, and landscape scale) affected density and nesting success of grassland-nesting birds in 13 fragments of native tallgrass prairie in southwestern Missouri.

At this time, further investigation of the relationship among habitat, habitat management techniques, and nest and brood predation are needed. This will require further identification of the complement of predators responsible for predation on nests with the use of photography, etc. and the development of new techniques to monitor brood mortality. Proactive private-lands programs need evaluation to provide guidance for future private-lands strategies. These long-term and expensive evaluation studies tend to be particularly difficult when dealing with small dwindling populations.

Recommendations

The remaining breeding range of the prairie chicken in Missouri is 4% of its original size. More than 80% of the remaining prairie chicken populations are associated with Missouri's remaining 1% of native prairie. The breeding range is fragmented into 50–70 distinct segments, most on privately owned land. If the past 28-year trend continues, Missouri's resident prairie chicken population will be gone by the year 2009!

To stop and reverse this deteriorating process, the establishment of key core areas through aggressive land acquisitions for grassland wildlife and proactive private-lands programs targeted to these same landscapes will be necessary. Government and private organizations within the state will need to complement each other's efforts. Where one fails another must succeed. The battle to secure habitat must be prioritized. Efforts have been spread too thin in the past for true grassland landscape species to benefit.

Acknowledgments

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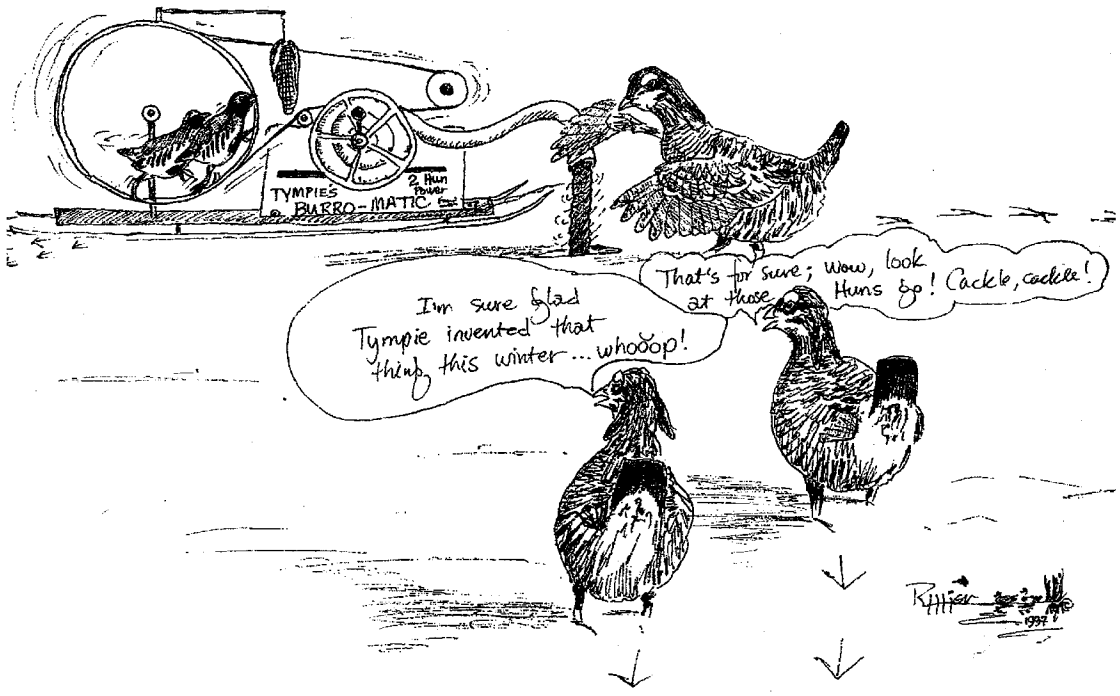

Status and Management of Greater Prairie Chickens in Illinois

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At the first meeting (1973) of the group that became the Minnesota Prairie Chicken Society, the current Illinois program for greater prairie chickens (*Tympanuchus cupido pinnatus*) had been underway for about a decade (Sanderson and Edwards 1966, Sanderson et al. 1973, Westemeier 1973). At that time, research, land acquisition, and habitat management were vigorously pursued. Results were positive and the outlook for Illinois prairie chickens was highly optimistic. Newly developed sanctuary grasslands were being used at densities beyond expectations, nesting success was high, and an increase of over 400% occurred between the mid-1960s and 1973 on the primary study area in Jasper County (Sanderson et al. 1973, Westemeier 1973). Thus, it appeared that sufficient information was available to preserve a population of prairie chickens. This was not the case.

In 1973, nest predation greatly increased on sanctuaries, and prairie chicken numbers plummeted (Westemeier 1985*a*). Most unmanaged Illinois populations were extirpated as land use intensified. Also, beginning in the 1970s, but especially significant by the mid-1980s, was the increase of pheasants (*Phasianus colchicus)* on the Jasper County sanctuaries. Interactions between pheasants and prairie chickens became a serious threat to the survival of the prairie chickens (Vance and Westemeier 1979, Westemeier and Edwards 1987, Westemeier 1988, Westemeier et al. 1998*b*). Control of nest predators and pheasants by sanctuary managers was eventually successful and land acquisition nearly doubled sanctuary grasslands by the mid-1990s in Jasper County (Westemeier 1997).

However, by the late 1980s and early 1990s, it became evident that small population size, isolation, fitness loss, and genetic deficiencies were significant factors in the continuing decline of Illinois prairie chickens (Westemeier et al. 1991, 1998*a*; Bouzat et al. 1998*a,b*). This revelation led Illinois Department of Natural Resources (IDNR) managers to develop and execute an action plan for translocating prairie chickens from large populations from other states for demographic and genetic enhancement of the remnant Illinois populations.

The quest to understand the role of many factors that influence prairie chicken numbers and how best to follow up with remedial action is an ongoing one. Key questions still needing answers include how many individuals are needed to comprise a viable popula-

tion and what is the quantity and varied structures of grassland needed to support such a population (Westemeier and Gough 1999).

The purpose here is to present an overview of the current status of Illinois prairie chickens, some results of prairie chicken translocations, and the main challenges still confronting efforts to have wild prairie chickens in our state. Some management concepts presented by Sanderson et al. (1973) and Westemeier (1973, 1985a) have changed and are modified herein.

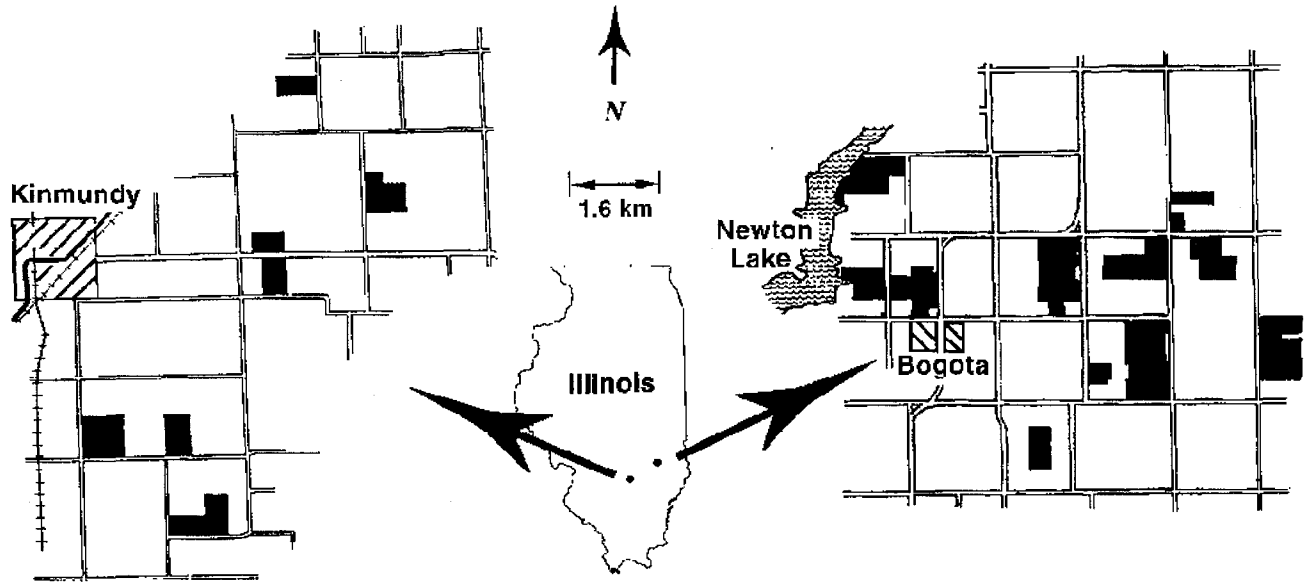
Study Areas

The primary study areas in Jasper and Marion counties include the sanctuary grasslands (Fig. 1) and surrounding landscapes of intensively farmed private land. In 1993 for example, land use types on the central core (2,560 acres [1,036 ha]) of the Bogota Study Area in Jasper County was comprised of 35% soybeans (*Glycine max*), 20% corn (*Zea mays*), 8% wheat (*Triticum aestivum*), and 30% grassland. Most grassland cover types were on sanctuaries. The few grasslands on private land near sanctuaries have included fescue pastures, wheat stubble/legumes, and weedy grass/forbs. Tall fescue (*Festuca elatior* var. *arundinacea*) is an undesirable invasive grass, and private fescue pastures were, and still are, typically too overgrazed to provide quality nesting or brooding habitat.

In the 1960s–70s, fall-seeded wheat was often overseeded the following winter with forage legumes. Wheat harvest occurred in late June at which time the resulting "stubble clover" afforded food and cover at least for broods 3–6 weeks of age. The stubble clover was either hayed in late summer and/or left undisturbed to be plowed down for soil enrichment the following spring, often before nesting prairie chickens could complete incubation.

Currently, wheat stubble is often seeded to soybeans with no-till drills, for a "double crop" in the same year. Weedy grass/forb mixtures (usually Federal set-aside acres) were also mowed in midsummer, often disrupting use by prairie-chicken broods. Yet, the weedy grass/forb type, now rare on private land, may have been an important factor for brood survival during the critical first few weeks after hatching.

Figure 1. Sanctuaries of managed grassland in the Prairie Ridge State Natural Areas of Jasper and Marion counties, Illinois, USA.



In 1998, Illinois sanctuaries totaled 2,396 acres (970 ha) with an approximate 50:50 ownership by the Illinois Department of Natural Resources (IDNR) and the Illinois Chapter of The Nature Conservancy (TNC). The Prairie Chicken Foundation of Illinois was the initial key player in sanctuary acquisition, but this group disbanded in 1973 after transferring paid-for land to the State of Illinois and remaining liabilities and assets to the TNC (Sanderson et al. 1973). The Illinois Natural History Survey (INHS) was responsible for managing TNC sanctuaries from 1965 to 1985, and all sanctuaries from 1973 to 1985; IDNR-Division of Natural Heritage has managed all sanctuaries since 1985. In 1997, a broadened ecosystem-based management approach was formulated to emphasize species of special concern, especially state endangered and threatened species (Simpson and Esker 1997). This change included renaming the prairie chicken sanctuary areas in Jasper and Marion counties collectively as "Prairie Ridge State Natural Area" (PRSNA).

Virtually all non-wooded sanctuary lands were in cropland at the time of acquisition. These were promptly seeded to introduced cool-season grasses such as redtop (*Agrostis stolonifera*), timothy (*Phleum pratense*), or smooth brome (*Bromus inermis*) and domestic legumes or native warm-season grasses. One exception was a 40-acre (16 ha) tract containing about 30 acres (12 ha) of native prairie vegetation. Among these grassland types, smooth brome was highly preferred as nest cover, even for prairie chickens translocated from Minnesota and Kansas prairies to Illinois (Westemeier 1985a, Westemeier et al. 1994). In Minnesota, Svedarsky (1988) found a similar preference for brome by prairie chickens on an area with a mix of native and non-native cover types.

Grassland management in Illinois has included grass seed harvests, rotary mowing (without seed harvests) at both high and low levels, late haying, prescribed burning, disking for brood habitat, leaving stands undisturbed, and some light-to-moderate grazing. Most soil types supporting Illinois prairie chickens were derived from prairie vegetation on level-to-gently rolling terrain between wooded stream corridors. Woodlots totaling about 160 acres (65 ha) remain on 5 sanctuaries.

Methods

BOOMING GROUND SURVEYS

Ellis (1964) used questionnaire cards distributed to vocational agriculture students in 47 high school districts over 20 southern Illinois counties to determine relative abundance and distribution of prairie chickens in fall 1962. Beginning in the spring of 1963, Ellis and colleagues also conducted booming ground surveys on 10 census areas in the occupied range which were surveyed until extirpation occurred. Surveys eventually involved 23 areas in 10 southern counties (Westemeier 1985a).

Booming ground surveys generally followed the Hamerstrom (1973) methodology, emphasizing counts during the peak of hen visitation. Peak visitation by hens occurs during the first 2 weeks of April in Illinois. At least 3 usable counts for each booming ground were obtained during this period to determine the number of regularly present males. Listening stop routes were run during calm (<10 mph [16 kmph]), rainless mornings by stopping at 1-mile (1.6 km) intervals for ≥1 min to ensure detection of all grounds. Volunteers in observation blinds on or near booming grounds often supplemented numerical data from standard surveys. In addition, booming grounds were checked for activity at least monthly during fall and winter.

TRANSLOCATIONS OF NONRESIDENT PRAIRIE CHICKENS

The translocations of greater prairie chickens during 7 years included 2 summer releases (August of 1992, 1993) and 5 spring releases (April of 1994–98). These were cooperative efforts with colleagues in Minnesota, Kansas, and Nebraska. Trapping methods followed those developed by Toepfer et al. (1988), as well as unpublished methods by Toepfer for summer trapping. All birds were leg banded.

Holding and shipping boxes were designed with individual compartments, buffered with cardboard to minimize injuries to birds. Transportation of prairie chickens to Illinois was via air-conditioned vehicles or aircraft. The average time from capture to release was 30 hours. Most birds were released at daybreak, as close to active booming grounds as possible. Radiotelemetry was used with all 27 of the Minnesota birds and 29 of those from Kansas (Rubin 1994, Westemeier et al. 1994, 1995). Booming grounds were monitored before and after April releases to obtain a rough estimation of the number of males that integrated into the populations in Jasper and Marion counties.

Results & Discussion

ABUNDANCE, DISTRIBUTION, DENSITIES, AND DECIMATING FACTORS

In contrast to the legendary abundance of prairie chickens throughout the state in about 1860 (Forbes 1912, Yeatter 1943, Westemeier 1985*a,b*), Illinois prairie chickens reached their lowest point in the spring of 1994 with an estimated 46 Illinois birds in Jasper and Marion counties combined. Ralph Yeatter (1943, 1963) started his booming ground surveys on about 4 mi^2 (10.4 km^2), near Hunt City in Jasper County in 1936, recording a peak of 131 booming males in 1939. These had declined to 4 by 1963. Extirpation of prairie chickens at Hunt City occurred by 1969 (Vance 1976).

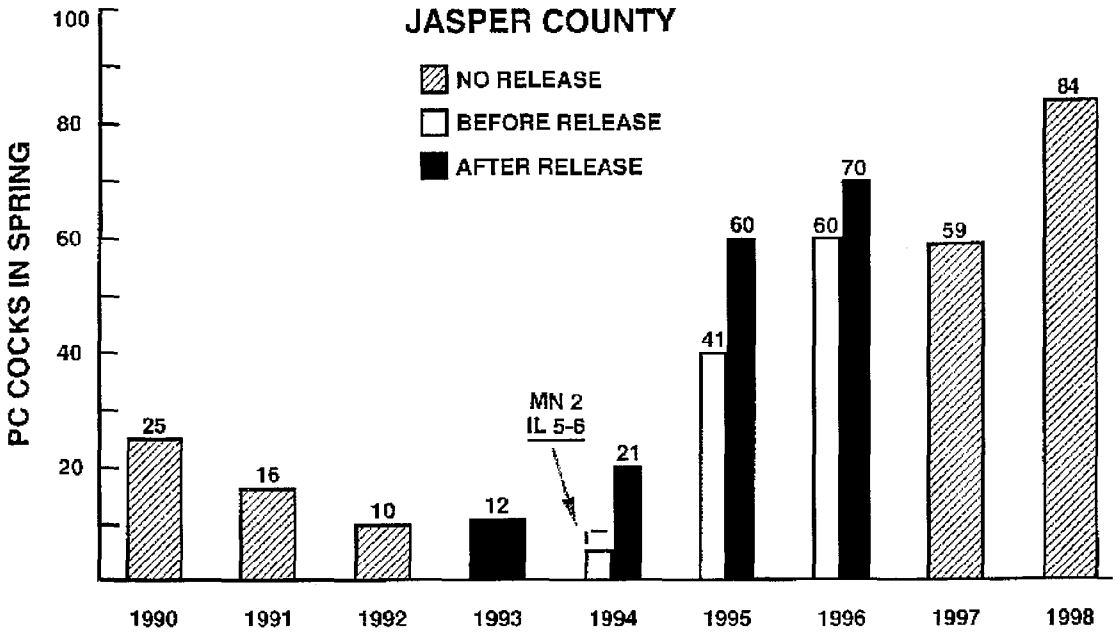
Ellis' (1964) questionnaire results revealed 179 reported flocks estimated at 2,000 prairie chickens distributed over 16 counties in 1962. These dwindled to the 2 sanctuary populations by 1984; a 100% loss of *unmanaged* populations in about 2 decades. A small remnant (1–7 males) reappeared in Clay County, between the 2 sanctuary populations for a decade only to disappear by 1994.

Two encouraging population highs were noted during the past 3.5 decades of managing remnant Illinois prairie chickens; one in Jasper County and the other in Marion County. In Jasper County, counts averaged about 40 booming males during the mid-1960s during a surge of land acquisition, seeding, growth, and management of sanctuary grasslands. Counts then steadily increased, beginning in 1968, reaching 206 and 205 males in 1972 and 1973, respectively (Westemeier 1985*a*). This occurred with only 660 acres (267 ha) of sanctuary grassland available to the birds by spring 1972. In Marion County, counts averaged 43 booming males during the 1970s, where sanctuaries were developing more slowly than those in Jasper County. Increases in Marion County during 1979–81 brought the count to 116 males in spring 1982 with only 450 acres (182 ha) of sanctuary grassland. Redtop and timothy were the primary sanctuary grass species, and grass seed harvesting was the main form of management that fostered both population highs (Westemeier 1985*a,b*).

During 19-year periods, breeding densities averaged 94 and 83 males/mi^2 (36 and 32 males/km^2) of managed grassland in Jasper and Marion counties, respectively. Hence, for nearly 2 decades 100 males/mi^2 (39 males/km^2) of managed grassland was apparently a realistic density goal for Illinois. This density goal was proposed for prairie chickens by Kirsch (1974). Expressing breeding density to include both grassland and surrounding cropland as Yeatter (1943) did for about 4 mi^2 (10.4 km^2), yields similar mean density estimates of about 20 males/mi^2 (7.7 males/km^2) for both the Hunt City and Bogota study areas (Westemeier, unpublished data). Two sanctuary systems, each with 1,500 acres (607 ha), well-situated, properly managed, and well-used by prairie chickens, appeared to be at least minimum goals with which to achieve preservation of the species.

Unfortunately, minimum land acquisition goals were not attained, other factors interceded, and the favorable population responses did not continue into the current decade. By the spring of 1994, the count of prairie chickens on booming grounds had declined to 5–6 Illinois males and 2 translocated Minnesota males in Jasper County. This brink of extirpation occurred despite a new record of

Figure 2. Estimated number of prairie chicken cocks in spring, before (1990-91), during (1992-96), and after (1997-98) releases of translocated birds from Minnesota (15 hens, August *1992; 8 cocks, 4 hens,* August *1993), Kansas (a total of 94 cocks, 100 hens,* April *1994 and 1995), Nebraska (25 cocks, 25 hens,* April *1996), Bogota Study Area, Jasper County, Illinois, USA. Open bars represent cock numbers observed during the early part (late March-early April) of booming seasons just prior to each April release. Shaded bars represent estimated cock numbers observed early to mid April after each April release. The difference in numbers before and after each of the 3 spring releases was believed to roughly represent the number of translocated cocks integrated into the breeding population.*



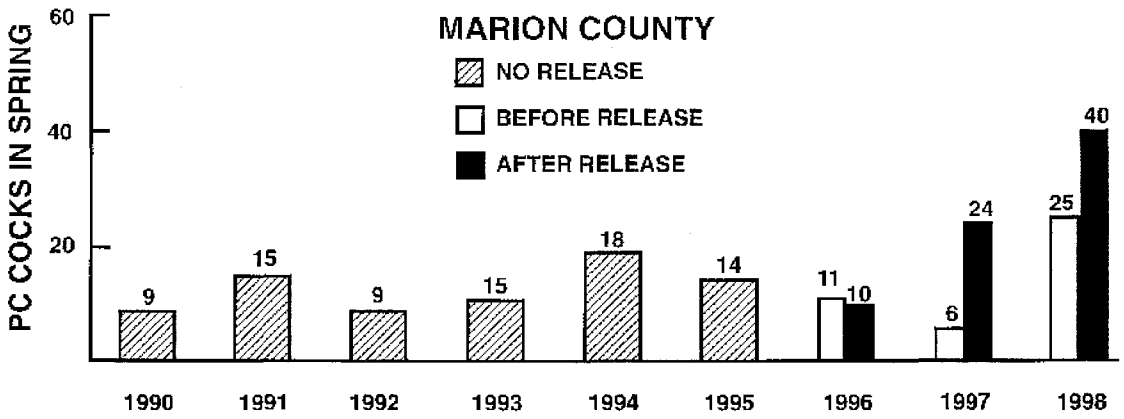
about 1,000 acres (405 ha) of managed grassland available in 1993 to the prairie chickens at Bogota.

The situation was not much better in Marion County where the number of males ranged from 9 to 18 from 1989 to 1996, with about 600 acres (243 ha) of sanctuary grassland. In addition to poor nest success due to predation in some years, intense interactions with pheasants, intensifying land use on private cropland adjacent to the sanctuaries, declining egg viability symptomatic of genetic deficiencies also became evident. Moreover, the more-peripheral sanctuaries in Jasper County continued to be little used by prairie chickens because of close proximity to woodlands and probably other factors. In Marion County, the 3 northern-most sanctuaries remained essentially unused since 1990, perhaps due in part to intensive spreading of domestic chicken manure that began in 1987 on nearby private farmland. Tall wooded fencerows were also negative factors on some Marion County tracts. Hence, only about half of the "available" managed grasslands on sanctuaries were being regularly utilized by prairie chickens in each county.

RESPONSES FOLLOWING RELEASES OF TRANSLOCATED PRAIRIE CHICKENS

Between August 1992 and April 1998, 518 greater prairie chickens (268 hens, 250 males) were tranlocated from 3 states and released in Illinois sanctuary areas. Responses were initally slow. Little change in numbers were evident after the 2 initial releases of 27 radio-tagged birds made in the summers of 1992 and 1993 in Jasper County (Fig. 2). The same was true for Marion County after a first spring

Figure 3. Estimated number of prairie chicken cocks in spring before (crosshatching, 1990-95) and during (each April 1996-98) releases of tranlocated birds from Nebraska (25 cocks, 25 hens in 1996) and Kansas (50 cocks, 50 hens in 1997; 50 cocks, 50 hens in 1998), Kinmundy Study Area, Marion County, Illinois, USA. Open bars represent cock numbers observed during the early part (late March-early April) of booming seasons just prior to each release. Shaded bars represent cock numbers observed early-to-mid April after each release. The difference in numbers before and after each of the 3 spring releases was believed to roughly represent the number of translocated cocks integrated into the breeding population.



release there, of 49 unradioed birds in 1996 (Fig 3). However, both remnant populations were revived from lows with no more than 6 Illinois males and probably fewer hens.

In Jasper County, the number of males by spring 1998 reached 84 males (Fig. 2) on at least 10 booming grounds, the highest level attained since 1982. All but 3 males were focused on or near the 3 central-most sanctuaries (Fig. 1), containing approximately 700 acres (283 ha) of managed grassland in 1998. Thus, the density of breeding prairie chickens on these 3 units was once again relatively high. Viewing breeding density in a conventional way, the 81 booming cocks in the interiors of 3 adjacent sections of mixed cropland and grassland translate into 27 males/mi^2 (10.4 males/km^2). This density, for example, nearly matched Wisconsin's top density of "28.0–29.5 cocks per section" on a "2x2 mile subsample" in 1950 (Hamerstrom et al. 1957:91).

In Marion County, virtually no change followed the first release in spring 1996. But increases of 300% (6 to 24 males) and 60% (25 to 40 males) were observed after the spring releases were made in 1997 and 1998, respectively (Fig. 3). Thirty-three (83%) of the post-release prairie chickens in 1998 were observed on or near the southern 3 sanctuary units (400 acres) in Marion County (Fig. 1). Surprisingly, a new booming ground appeared with 5 males in the spring of 1997 near the commercial egg-production facility. It had 6 males prior to the 1998 release, and gained another male after the 1998 release. The 1998 count for Marion County was the highest since 1987.

In addition to the marked responses in the 2 sanctuary areas, we verified 1 to 2 males in at least 4 other areas. In 1997 and 1998, 1 male was located on Ralph Yeatter's old study area near Hunt City, in northeastern Jasper County. There were unverified reports of prairie chickens in several other areas as well, following releases of translocated birds.

The positive responses attained thus far by the translocations from Minnesota, Kansas, and Nebraska are indeed encouraging, at least for the short term. However, given the amount of habitat available, and the size of the current populations in Illinois, they may

not remain viable for long. On the basis of historical evidence, Toepfer et al. (1990:575) called for minimum populations of at least "200 birds or 100 displaying cocks" because populations of lesser size are likely to "eventually disappear without habitat improvement or acquisition." Significant habitat improvements are ongoing in Illinois and new acquisitions totaled 275 well-situated acres in 1995, near Bogota in Jasper County (Simpson and Esker 1997). As noted above, roughly only half of the managed grasslands in both counties are currently well utilized by prairie chickens. However, the distribution of prairie chickens could improve greatly in response to the stepped-up levels of tree removal, new grass seedings, prescribed burning, and other improvements now underway. The high densities attained from the late 1960s through the mid 1980s, and again in 1998 in Jasper County, offer hope that favorable increases in population size are indeed possible.

A combination of high densities and fullest possible utilization of available grasslands by prairie chickens may be essential because minimum viable population size could well be more than twice that (100 males) proposed by Toepfer et al. (1990). Westemeier and Gough (1999) base this contention on long-term booming ground surveys, especially in Wisconsin, which suggest minimum populations to be those with >250 males.

BENEFITS TO OTHER GRASSLAND SPECIES

Species other than prairie chickens, especially those endangered and threatened, on or near sanctuary grasslands in Illinois, have not been overlooked. A holistic approach may be especially important for promoting needed improvements and increased habitat protection and development at PRSNA of Jasper and Marion counties. Reports on grassland-dependent species (other than prairie chickens and pheasants) using Illinois sanctuaries include those by Buhnerkempe (1979), Westemeier and Buhnerkempe (1983), Westemeier (1985a), Buhnerkempe and Westemeier (1984*a,b*; 1988), Westemeier (1986, 1989, 1991, 1994), Westemeier et al. (1989, 1997), Simpson and Esker (1997), Walk et al. (1998), Walk (1998*a,b*), and Herkert et al. (1999).

Current management for the PRSNA emphasizes 36 species of special concern (31 birds, 2 reptiles, and 3 plants) which occur at this site. These include 17 state-endangered species, 8 state-threatened species, 6 watch-listed species, and 5 additional area-sensitive species (Simpson and Esker 1997). In short, the PRSNA has become "home to the most significant grassland bird populations in the state" (Walk et al. 1998:22). For example, the area hosts the state's largest breeding population of northern harriers (*Circus cyaneus)* and short-eared owls (*Asio flammeus*) (Simpson and Esker 1997) and the largest wintering populations of these raptors in the Midwest (Walk et al. 1998). Further, as Walk (1998a:10) noted, the PRSNA "has not been fully appreciated for its grassland bird density and diversity." Thus, greater concern for biodiversity and an ecosystem approach to grassland management for prairie chickens seems warranted.

Management Implications

Despite past successes, minimum viable populations (MVPs) of prairie chickens have not been maintained in either Jasper or Marion counties of Illinois. To attain MVPs, more managed grasslands with plant structures suitable to meet the year-round needs of prairie chickens must become a reality. The 2 scatter-patterns of grasslands may require 4,000 acres (1,620 ha) of habitat protection and development in each county (Simpson and Esker 1997). This level of management allows for (1) tracts that may never be well utilized by prairie chickens, (2) providing adequate brood cover for prairie chickens, (3) greater consideration for other endangered and threatened species, and (4) restoration of Southern Till Plain prairies.

Ongoing, or at least periodic, nest studies and/or genetic evaluations will likely be needed to assess fitness and genetic variation in prairie chickens. If new research reveals another decline in fitness and more genetic

deficiencies, translocations of prairie chickens from large populations may again be needed.

Recent responses by prairie chickens and by the array of other grassland and wetland species are encouraging, at least in the short term. For the long term, however, more suitable grasslands are urgently needed for increased biodiversity, grassland species in particular.

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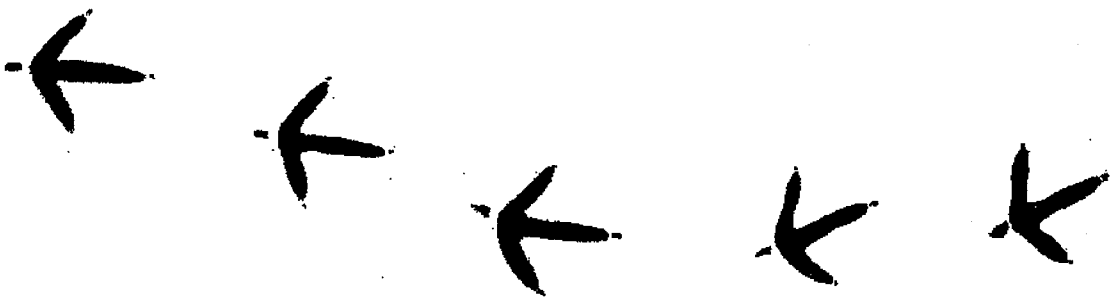

The Attwater's Prairie Chicken — A Lesson in Conservation Biology Research

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Introduction

In 1967, when the Attwater's prairie chicken (APC; *Tympanuchus cupido attwateri*) was listed as endangered by the U.S. Fish and Wildlife Service (FWS), approximately 1,070 individuals resided in 14 counties (Lehmann 1968; Aransas, Austin, Brazoria, Calhoun, Chambers, Colorado, Fort Bend, Galveston, Goliad, Harris, Jefferson, Refugio, Wharton, and Victoria). Its original range extended from the Nueces River in Texas to Abbeyville, Louisiana, and peak numbers were estimated at between 300,000 and 1 million individuals on 5.5 million acres (2.4 million ha) (Lehmann 1941, 1965).

Numbers of APC declined to 8,700 individuals on 450,158 acres (182,250 ha) by 1937 (Lehmann 1941), 4,200 individuals by 1950 (Jennings 1950), 1,335 individuals by 1963 (Lehmann and Mauermann 1963), and 1,070 on 234,082 acres (94,770 ha) by 1967 (Lehmann 1968). In 1980, when the last status update was published (Lawrence and Silvy 1980), the population had increased to 1,584 individuals on 297,413 acres (120,410 ha). The distribution of APC in 1980 had decreased to 10 Texas counties: Aransas, Austin, Brazoria, Colorado, Fort Bend, Galveston, Goliad, Harris, Refugio, and Victoria. Lawrence and Silvy (1980) predicted the APC population would remain relatively stable during the 1980s, given no catastrophic events; then a long-term downward trend was predicted if additional lands were not managed to benefit the APC. In 1980, less then 9,880 acres (4,000 ha) were managed for the APC on the Attwater Prairie Chicken National Wildlife Refuge (APCNWR) and the Aransas National Wildlife Refuge (ANWR).

In an effort to save the APC from extinction, many government agencies (Texas and Feder-

al) and non-profit organizations have worked together to help the APC. Past and current efforts (published and non-published) by these agencies and organizations have and are contributing greatly to save the APC from extinction. This paper chronicles only conservation research efforts by the senior author and his students to help in this effort to prevent the extinction of the APC. The authors recognize that conservation biology includes more areas than research, however, only research at Texas A&M University (TAMU) will be dealt with in this paper. This paper also updates the status of the APC since 1980 and discusses the bird's future.

Current Status

The APC had a spring 1998 population of 56 individuals inhabiting the coastal prairies of Texas (FWS, unpublished data). This estimate represents a 96% decrease from the 1980 estimate of 1,584 birds. Estimates between 1980 and 1998 ranged from a high of 1,620 birds in 1984 to a low of 42 birds in 1996 (U.S. Fish and Wildlife Service, unpublished data). As predicted by Lawrence and Silvy (1980), the population remained relatively stable for nearly 8 years then declined more than 53% from 1988 to 1989.

Lawrence and Silvy (1980) estimated the APC occupied 297,413 acres (120,410 ha) in 1980. In 1998, 3 populations of APC occupied about 17,784 acres (7,200 ha) of this former range. Although occupied range has decreased by at least 94% from that used in 1980, there are still sizeable areas that appear to offer all the requisites to support APC. However, populations have gone extinct in these areas. Many of these areas are now isolated from remaining APC populations and repopulating them would require reintroduction. Less than 145,730 acres (59,000 ha) of occupied and potential prairie chicken habitat remain in 1998. This estimate is less than 49% of the habitat used by APC in 1980.

In spring 1998, the largest population of APC was in Galveston County where 18 males were seen on display grounds on one ranch of about 1,729 acres (700 ha). This is down from the 96 birds and 6694 acres (2,710 ha) of estimated habitat in 1980. Urban-industrial development led to this decline. The population in Galveston County peaked at 110 individuals in 1981 and continued to decline to 16 individuals in 1996. In July 1996, 19 captive-reared birds were released into the Galveston population. Additional birds were released in late summer 1997. Following release of captive-reared birds (19 in 1996 and 18 in 1997), the population has gradually increased to an estimated 36 individuals in spring 1998. The population in Galveston County came under the control of the Texas Chapter of The Nature Conservancy (TNC) through a donation by Amoco Oil Company in 1995.

In 1980, Refugio County held the largest population of APC. In spring 1998, only 6 males were sighted in Refugio County. The birds were located on a single display ground in an 8,000-acre (3,200-ha) pasture. This is a 94% reduction from the 7,904 acres (49,540 ha) occupied in 1980 (Lawrence and Silvy 1980). The estimated 12 individuals for 1998 is a 98% reduction from the number of birds (726) found in Refugio County during 1980. The population in Refugio County peaked in 1984 with an estimated 838 birds and is currently at an all time low.

The third population of APC (8 individuals) is found on the APCNWR in Colorado County. The APCNWR was supplemented with 13 male APC in 1995, 50 birds of both sexes in 1996, and 33 birds of both sexes in 1997. In 1980, there were 186 chickens using 37,396 acres (15,140 ha) of habitat in Colorado County. In 1998, all 8 remaining birds were located on the 7904-acre (3,200-ha) APCNWR. Little, if any, potential habitat remains elsewhere in Colorado County. The Colorado County population peaked at 320 birds in 1983 .

Continuous with the Colorado County population in 1980 was the Austin County population of 326 chickens on 38,507 acres (15,590 ha). Birds in Austin County declined after 1980 and were last seen in 1995. During the past 18 years, populations of APC have gone

extinct in Aransas, Austin, Brazoria, Fort Bend, Goliad, Harris and Victoria counties. Birds were no longer found in Aransas or Fort Bend counties after 1991, in Goliad County after 1993, and Victoria County after 1992. In 1982, the remaining 20 individuals in Brazoria County were lost when hurricane Alicia hit this area (Silvy and Morrow 1988). This potential habitat in Brazoria County remains and is now part of the Brazoria National Wildlife Refuge (BNWR) .

Research

HABITAT STUDIES

Research on the APC began during fall 1974 when the FWS requested assistance in determining why numbers of APC on the ANWR were decreasing. Refuge personnel were particularly interested in determining which vegetation types were most used by the APC so they could both better manage public lands and use these data when evaluating potential land purchases. Because the APC on ANWR was considered a "spill-over" population from the much larger population in adjoining Refugio County, research was initiated in Refugio County where all APC occurred on private lands. Ranchers in Refugio County encouraged research conducted on their properties. Trapping and radio-telemetry tagging of APC started in January 1975 in Refugio County.

Horkel (1979) determined cover and space requirements for APC in Refugio County. He noted that of 8 major vegetation types recognized, the birds were located 76% of the time in 1 vegetation type (clumped midgrass) and all APC nests were located within 2 types even though they comprised only 52% of the area. It was then apparent that future land purchases should include these 2 vegetation types (clumped and unclumped midgrass). It appeared that APC used these types because they had a mean annual vegetation height below 22 inches (55 cm) and an annual mean visual obstruction (Robel et al. 1970) of 2.5 dm or less (Cogar et al. 1977). Cogar (1980) determined that food was not limiting in all 5 of the 8 vegetation types the APC used and they fed mostly on forbs, with insects being important in summer .

Horkel and Silvy (1980) compared the behavior of APC to that of the greater prairie chicken (GPC; *T. c. pinnatus*) and found the breeding hierarchy of APC leks were unstable. The apparent breakdown of territories was related to extreme linearity of the leks (roads and oil pipelines being used as leks). They proposed the increased number of leks caused by oil development and the instability of linear leks might lead to less "fit" males breeding, thereby degrading the genetic fitness of the populations. Lutz (1979) determined that oil development positively affected food availability due to the mowing of oil pipeline rights-of-way. Lutz and Silvy (1980) studied artificial nests and found few differences in the vegetative cover at nests disturbed or undisturbed by predators. Predation on artificial nests appeared to be area specific and was influenced by vegetation at the nest site.

Lawrence and Silvy (1987) evaluated the effectiveness of a 1979 transplant of APC from Galveston County to Victoria County. Twenty-five (12 males and 13 females) birds were radio-tagged when released. Only 1 bird survived >1 year and no hens produced young. Reasons for the transplant failure included translocating adults only, inappropriate release habitat, and drought. Horkel et al. (1981) looked at rights-of-way as potential habitat for APC and noted APC used mowed rights-of-way as feeding sites. Lawrence (1982) found that controlling small mammalian predators increased nesting success by about 50%, but that limiting the raptorial prey base caused raptors to increase predation on older APC, thereby negating the benefits of the increased nesting success .

Morrow (1986), also using radio telemetry, collected data on habitat use, movement, and survival of APC on the APCNWR. He estimated annual adult survival at between 10.8 and 35.5%. Nesting success averaged 35% during his 3-year study. Survival of broods was 34% for 8 weeks post hatching. Annual range size for females and males averaged 1470 and 889 acres (595 and 360 ha), respectively.

Morrow (1986) found that APC selected second-year and older burns on loamy grasslands during winter. During spring, males and nonreproductive females also selected for these range types. Additionally, grassland cover with an obstruction of vision value in the 2-dm range was important during the critical winter and nesting periods. Eighty-five percent of nests were found in third-year or older burns. Broods of young birds used grassland typified by second-year and older burns on loamy and sandy areas. After mid-June, broods used more open coarse sand and first-year burn areas.

DiMare (1991) observed APC at 3 leks of different shape (circular, intermediate, and linear) in Refugio County and compared reproductive success of dominant males on these grounds. The number of males regularly attending each lek did not differ across leks and years. More males were involved in copulation at the circular lek than either the intermediate or linear leks. Mating success was higher at the linear lek than either the intermediate and circular leks. There was no evidence females were delayed or prevented from mating on linear leks. DiMare (1991) also noted that total frequency of a booming call and frequency of the third note alone could be used to separate males that copulated from most males that did not copulate. It appears that calls of males that mated differed from those of non-mating males. Further research is needed to determine if females are keying on such males.

GENETIC STUDIES

Ellsworth (1991) and Ellsworth et al. (1994) examined the prairie grouse complex (*Tympanuchus*) which occurs throughout the Central Plains of North America to assay patterns of extranuclear and nuclear gene variation among these species. The phylogenetic distribution of mitochondrial DNA haplotypes and the pattern of allozymic variation in prairie grouse were neither geographically partitioned nor taxonomically constrained. Mitochondrial DNA variation was characterized by limited differentiation from a predominant haplotype common to all taxa. This suggests a recent speciation (<100,000 years before present) with the prairie grouse complex. Thus, considerable morphological divergence in prairie grouse, perhaps accentuated by behavioral isolating mechanisms, appears to have progressed with relatively little accompanying extranuclear or nuclear gene differentiation among species. Despite the absence of interspecific genetic differentiation, there was indication of subdivision among conspecific populations. The propensity for allozymic differentiation among prairie grouse populations relative to other avian species may reflect components of prairie grouse reproductive behavior, social organization, and contemporary alterations of prairie grouse habitat.

Ellsworth et al. (1995) used mitochondrial DNA to generate a phylogeny for North American tetraonides. Using the northern bobwhite (*Colinus virginianus*) as an out group, the molecular phylogeny partitioned species into 3 primary groups: (1) GPC, lesser prairie chicken *(T. pallidicinctus),* and sharp-tailed grouse (*T. phasianellus*); (2) willow ptarmigan (*Lagopus lagopus*), white-tailed ptarmigan (*L. leucurus*), rock ptarmigan (*L. mutus*), and blue grouse (*Dendragapus obscurus*); and, (3) ruffed grouse (*Bonasa umbellus*), spruce grouse (*D. canadensis*), and sage grouse (*Centrocercus urophasianus*). Hence prairie grouse were genetically distinct from other grouse species. Willow and rock ptarmigans were more closely related to each other than either was to the white-tailed ptarmigan. The spruce grouse grouped with the ruffed grouse, whereas the blue grouse was allied with the ptarmigans. Thus, the genus *Dendragapus* as currently constructed is polyphyletic (spruce grouse and blue grouse have had separate evolutionary histories). The morphological similarities between the 2 species may be attributable to convergent adaptation to coniferous forest.

Osterndorff (1995) used high molecular weight genomic DNA isolated from chorioallantoic membranes of hatched APC eggshells and successfully obtained DNA fingerprints. Results indicated chorioallantoic membranes could provide a non-invasive means of genetically sampling the endangered APC and other avian species. Osterndorff (1995) also used

DNA fingerprints to assess genetic variability of captive and natural populations of APC. Levels of genetic variability in the 3 remaining natural populations were compared to one population of greater prairie chickens from Kansas. At least 2 of the 3 remaining APC populations have suffered a reduction in genetic variability, presumably as a result of prolonged small size.

LIMITING FACTORS

As predicted by Lawrence and Silvy (1980), habitat loss has gradually reduced APC numbers. However, the dramatic decrease in numbers observed during the last 18 years cannot be attributed solely to habitat loss. Reduced environmental quality, infectious agents, inbreeding, and environmental stochasticity might have contributed to this rapid decline.

Horkel et al. (1978) looked at the influence of environmental parameters on APC nesting success in Refugio County and found nests located in fragmented habitats were destroyed by predators more than were nests in non-fragmented habitats. Lutz et al. (1994), also working in Refugio County, noted that initial nest success ranged between 19 and 64% annually. Renesting success varied from 0–51% and did not occur in 2 of 5 years. Hen survival averaged 36% during spring. They hypothesized that observed declines in abundance were caused by low female survival during nesting and limited renesting.

Peterson (1994) evaluated numerous factors that might limit numbers of APC throughout their range. The accepted hypotheses (Lehmann 1941) that greater than normal spring (March–June) or May precipitation led to decreased APC breeding numbers the following spring, while drought during this period led to increased numbers, were not supported by the data (Peterson and Silvy 1994). However, reproductive success could account for breeding numbers the following spring .

To delineate which reproductive stages were most limiting to APC numbers, Peterson and Silvy (1996) tested the hypotheses that APC reproductive productivity (as measured by summer number of juveniles per adult), clutch size, egg hatchability, nesting success, brood survival, and chick survivorship were less than those of GPC. The APC ratio of juveniles per adult, nesting success, and number of chicks per brood prior to brood breakup were significantly less than those typically seen for the GPC. Insufficient data were available to compare brood survival. Peterson et al. (1998*a*) used a computerized model that explicitly represented prairie chicken clutch size, egg hatchability, nesting success, brood survival, survivorship of chicks within successful broods, and juvenile and adult survival to evaluate parameters Peterson and Silvy (1996) found might limit APC reproductive productivity. When long-term nesting success, brood survival, and the number of chicks per brood prior to brood breakup were individually increased, values for each parameter had to be substantially greater than typically seen in GPC populations before the decline in APC numbers was reversed (Peterson et al. 1998*a*). When these 3 variables were increased simultaneously, approximately 90% of the difference between APC and GPC values had to be closed before the decline in number was reversed .

Peterson (1996) analyzed the geographic incidence of prairie grouse helminthic endoparasitism and predicted APC populations should maintain parasite diversity similar to GPC populations surveyed in Illinois, Kansas, and Missouri. Additionally, he predicted that APC might be expected to harbor parasites not previously identified in prairie grouse. When these hypotheses were tested, Peterson et al. (1998*b*) identified *Dispharynx nasuta* and *Trichostrongylus cramae* in 1 of 3 and 8 of 9 suitable APC samples, respectively. Although *D. nasuta* had been observed in GPC parasite surveys in Kansas and Missouri, *T. cramae* had not previously been documented for prairie grouse. Additionally, samples from 4 of 27 adult males were serologically positive for *Pasteurella multocida* antibody, while antibodies for 8 other infectious agents were not detected (n = 19). No hemoparasites were observed (n = 24 samples, Peterson 1994).

Purvis (1995) compared infectious agents found in sympatric geese, northern bobwhite,

and APC populations. Geese harbored 3 cestodes, 7 nematodes, and 3 trematodes (Purvis et al. 1997). Northern bobwhite harbored 1 cestode, 4 nematodes including *T. cramae* (Purvis et al. 1998), and numerous unidentified lice and mite species (Purvis 1995). Geese appeared to harbor fewer parasites potentially harmful to APC than did northern bobwhite. However, geese, quail, and APC had positive antibodies for *P. multocida* and all 3 harbored nematodes of the genus *Trichostrongylus* (Purvis et al. 1997, 1998; Peterson et al. 1998*b*). This finding could be of concern because *T. tenuis* has been shown to limit red grouse (*Lagopus lagopus*) populations in northern England and Scotland (Peterson et al. 1998*a*).

CAPTIVE PROPAGATION

In spring 1991, TAMU received wild-caught GPC from Kansas to develop captive techniques for future use with APC. Drake (1994) found that chicks generally died before they would adapt to commercial turkey starter. He solved this problem by feeding young prairie chickens wild-caught insects during their first 8 weeks of life, gradually converting them to commercial feeds after 4 weeks of age. He experimented with rearing chicks by: (1) hand-rearing GPC chicks in an indoor brood pen; (2) using a domestic bantam hen and letting her rear the chicks in an indoor brood pen; and (3) using domestic trainer chicks with GPC chicks to encourage them to eat chick starter sooner. All methods produced similar results, however, both the domestic hen and trainer chicks competed with the prairie chickens for insects, so he concluded that chicks reared by hand was the best method for rearing GPC.

In January 1993, a Population and Habitat Viability Assessment for the APC was conducted (Seal 1994). Participants concluded the APC would face immediate extinction if captive propagation was not intensified. Fossil Rim Wildlife Center (FRWC) had established a captive flock of APC in 1992 and TAMU obtained eggs from wild nests in 1994 and successfully started a second captive APC flock. The Houston Zoo (HZ) established a third flock in 1994 and San Antonio Zoo (SAZ) a fourth flock in 1996.

In July 1995, 13 excess males from FRWC and HZ were released on the APCNWR. Two birds survived to the breeding season and 1 survived to 1 year post-release. During summer and fall 1996 and 1997, 120 captive-reared birds of both sexes were released on the APCNWR and on the TNC property in Galveston County. All released birds were monitored using radio-telemetry techniques (Lockwood 1998). About 40% of all birds survived to 1 January and both males and females were reproductively active during the spring breeding season.

During fall 1994, the TAMU captive flock contracted reticuloendothiosis virus (REV), which is an immunosuppressive retrovirus (Drew et al.1998). Captive flocks had not previously been tested for this infectious agent. The disease was discovered after testing a histological section of external lesions resembling avian pox. Although the avian-pox virus was isolated from these samples, REV also was discovered. REV now has been isolated from both APC and GPC at the TAMU facility, HZ, FRWC, TAMU-Kingsville (an APC holding facility), and a wild male from Refugio County was found positive for REV antibody. As a result, TAMU implemented a plan to eradicate the disease from the facility by isolating all positive APC in a quarantine room and euthanizing all positive GPC once the virus was isolated. Griffin (1998) found these methods successful for controlling REV at the TAMU facility.

Griffin (1998) developed methods of photoperiod manipulation to produce laying periods outside the normal laying periods for both APC and GPC. Using photoperiod manipulation, he was able to hybridize APC and GPC. He later successfully crossed hybrid hens to both male APC and GPC, producing second generation hybrids .

When a pilot release of excess male APC determined that many of the released birds died from starvation, Griffin (1998) evaluated the effects of food and water deprivation on GPC. It appears that birds can obtain sufficient wa-

ter if vegetation is available, however, APC needed to go through a preconditioning period at the breeding facility prior to shipment to release pens. In addition, food and water should be made available at the release pens to aid the birds in their transition to the wild.

Research Relevance

In the field of conservation biology, research in itself has little value unless it can be put to use. Research during the past 24 years by the senior author and his students has provided knowledge that has been incorporated into conservation efforts to save the APC from extinction. Research on APC habitat use and factors limiting APC populations have lead to more focused management efforts, including land acquisition .

Understanding the phylogenetic relationship of APC with GPC and other tetraonides provided information on possible inbreeding in the small APC populations. Hybridization may become important as a population management tool if on-going management efforts prove futile. The development of genetic tools to sex chicks, determine adult relationships, and determine female-offspring relationships from egg-shell membranes has helped captive breeding facilities better manage their flocks.

Research must play an integral role in the development of new programs and techniques. The program for rearing APC in captivity and subsequently releasing them into the wild is still in its infancy. We, along with other participants in the APC recovery program, have actively contributed to the captive rearing methods for APC chicks, preconditioning methods for chicks prior to release, and methods to control disease spread within captive facilities have and will increase production of captive APC. Knowledge gained by following radio-equipped captive APC at release sites, has and will continue to provide insight into methods that will improve bird survival. Understanding the physiological changes that released captive APC experience has led to better release methods and also has increased survival of these birds.

Knowledge is never complete and our research will continue in an effort to prevent extinction of the APC. Currently, research focuses on the determination of methods by which REV is transmitted within and between flocks of captive APC. New methods are always being tried in order to make captive breeding and reintroductions more efficient. Allowing hen APC to rear their own young offers some promise, however, there is a trade-off in chick survival (greater with hen-reared) and the number of eggs that can be obtained from a single hen (if allowed to rear her own young, only 1 clutch of eggs will be produced). Further research is needed on the use of photo stimulation to produce multiple breeding seasons during a single year .

If APC populations are to become self sufficient, there needs to be a better understanding of why APC nest success and brood survival are lower than those of GPC. Concurrent studies of APC and GPC (within the heart of the GPC range in Kansas) are needed to understand these differences. It also would be of interest to compare the results of these 2 studies to areas where GPC are decreasing (e.g., on the periphery of their range in Kansas). Future research also is needed on the role of environmental stochasticity in the population dynamics of small isolated prairie chicken populations. Specifically, information is needed to maintain populations capable of withstanding the adverse effects of future environmental variability.

Future Outlook

Currently, the APC is probably the most endangered bird in the United States. A regression of estimated numbers and time (1972–92) indicated the APC would be extinct by the year 2000. Only through supplementation of the existing populations with captive-reared birds will the current populations survive beyond the year 2000. All remaining wild birds were probably gone from APCNWR by 1998 as no wild males were seen in spring 1998. Supplementation (1996–97) led to increased numbers of APC on TNC lands. Supplementation offers hope for these 2 populations. How-

ever, prospects for population supplementation in Refugio County are not good as local ranchers currently view endangered species and private property rights as incompatible. We therefore predict the Refugio County population will be extinct by the year 2000. However, with extinction may come hope for APC in Refugio County. For once the original birds are gone, ranchers may be favorable to reestablish an "experimental population" on these areas. Under the Endangered Species Act, these populations do not carry the real or perceived private-lands rights problems associated with an endangered species.

Future reintroductions, using captive-reared birds, into Brazoria County on BNWR lands, into Aransas County on ANWR lands, and in Matagorda County on The Nature Conservancy's Mad Island Preserve offer additional possibilities for reestablishment of small populations. However, continued brush encroachment from adjoining lands may limit the potential of these areas. Efforts should begin now on these areas to maximize the habitat required by APC before future releases are made.

It appears the near future of the APC is in the hands of the captive breeding programs (FRWC, TAMU, HZ, and SAZ). Continued supplementation will probably be needed to support current populations and reintroductions. However, supplemental releases and reintroductions are limited to a few areas and at some point populations must become self-sustaining if our efforts are to be of value.

If the cost of water used for rice farming continues to rise, much of the rice farming will cease in Texas. With this will come the opportunity to convert some of these areas back to native prairie and cattle production. Efforts are needed to encourage farmers to return these areas to native prairie. By sustaining the current populations of APC through continued supplementation, we hope the time will come when these populations will naturally repopulate restored prairies. There are many "ifs" in the future for the APC, but there is hope so long as the APC is only down and not out. Even if conservation efforts to save the APC fail, lessons learned from the efforts should be helpful to others working on endangered species conservation biology.

Acknowledgments

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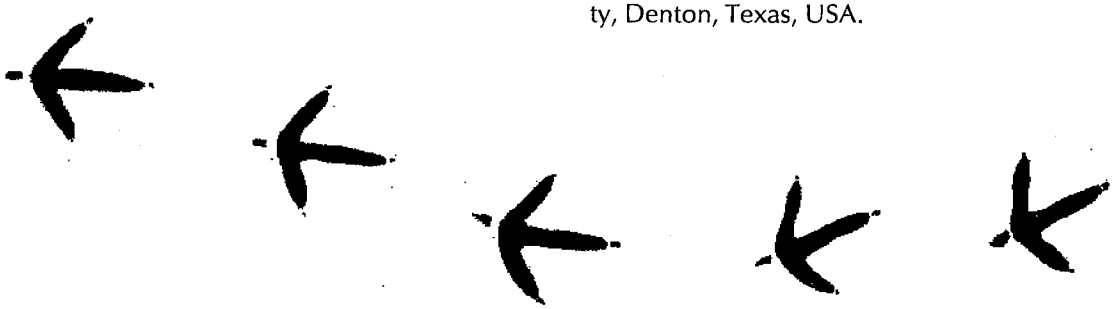

History and Hunting the Greater Prairie Chicken: A Rich Tradition

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People tend to think of this grand gamebird as belonging to the era of black and white photographs but it doesn't need to be that way (Fig. 1). Prairie chicken hunting is directly bound to the color and grandeur of the bird and its amazing habitats. If you are a "chicken hunter," you're not obsessed with them only in the fall. Odds are it was their primeval courtship antics that drew you to them and their vast grassland kingdom in the first place. In most areas, this is a kingdom whose boundaries seem defined only by the horizon your eyes could see, a kingdom so powerful it caused many humans to stare in disbelief for hours. Later, many scribbled down notes that eventually become sentences which eventually become books describing their intimate thoughts on the land of the prairie chicken.

Paul Gruchow, William Least Heat-Moon and Tom Huggler come to mind when thinking about some of the descriptions of "a prairie chicken's backyard." They can lead you to it, but it is much better when observed first-hand. As you explore it, you walk among bluestem, dropseed, and grama grasses, and blazingstars, purple coneflowers and sunflowers. Although it may not happen on your first hunt, or even your second, eventually you will fall into the grip of the grassland mystique and then immediately realize that every fallen bird is but the ultimate gift from an already giving landscape.

As a Euro-descended man, I cannot claim bragging rights on being the first to hunt this prairie grouse. Although many Plains Indians hunted them and honored them in story, song and dance; they cannot make such a claim either. The first hunters prairie chickens feared for thousands of years came in the form of feathered lightening bolts and fur-covered

Figure 1. Home from the hunt in Crookston, Minnesota, 1907. Caption on back of old photo, "In Harry Stair's backyard and the pup that died in October."

wraiths. We know them as peregrine and prairie falcons and red fox, just to mention a few.

In the relatively recent historical era, chickens expanded their range and increased in number as settlers moved onto the plains and broke-out small cropfields within the sea of grass. As more cropland was created, chickens did well until the ideal ratio of grass to cropland was exceeded.

Chickens were extremely important to pioneer families (Fig 2.). Their abundance in the late nineteenth century kept many homestead families in fine red meat when other foods were scarce. Their exceptional populations also provided for phenomenal kills for commercial markets and sportsmen of that era. For a period of years in the late 1800s and early 1900s, prairie chicken numbers were so tremendous in a vast area of the Great Plains that they more or less created a "chicken hunting culture." This culture was epitomized by large gatherings of high society folks who had the dollars and time to attend wild bird dog trialing events, or individual outings catered to hunting chickens. Many local train lines established special rates for prairie chicken hunters, even providing fine quarters for their hunting dogs. Other private sector entrepreneurs created items specifically designed for the prairie grouse hunter, such as a horse-drawn wagon which came complete with gun racks, dog kennels and large ice-boxes.

This era of "super-abundance" eventually ended as habitat loss, habitat succession, excessive market kills, weather, and other factors led to declining populations in many states. Concern by admirers for the pinnates' plight led to improved management, habitat acquisition, and other work to secure and strengthen dwindling chicken populations.

What follows, below, are some prairie chicken hunting notes from various states:

Figure 2. Members of the Ouse family near Rothsay, Minnesota in the early 1900s.

Iowa

(Moe 1999)

This state set the first daily bag limit on greater prairie chickens at 25 birds/day.

- 1880s = Peak numbers of chickens
- 1915 = Restriction of 8 birds/day and a season from September to December
- 1916 = Season closed (not reopened yet)

Minnesota

(Swanson 1940)

The first market quotes for "pinnates" was in 1859.

- 1870 = Duluth hotel managers ordered 1,200 chickens from the St. Paul markets
- 1876 = Season opener for prairie chickens was 15 August
- 1894 = Markets paid 30 cents/pair of chickens in August 1859; 70 cents/pair in September
- By late 1800s = farmers lobbied for later season openers to allow chickens to consume crop insect pests
- 1880s = Peak chicken numbers. The abundant prairie chicken was a major "tourist" attraction in much of western Minnesota where it was estimated that 1,000 hunters spent an average of 15 days and $60,000 annually
- 1870s = chicken hunters and Northern Pacific Railroad doing business
- 1899 = the Great Northern and Soo Line Railroads still held special chicken excursions with a 25-cent fee for dog care
- From 1850 through the 1870s = daily bags were commonly 35–50 birds/hunter
- Special "sporting wagons" were produced by several companies from which to hunt chickens; they came complete with 4–6 dog kennels, ice chests, gun racks and ammunition holds
- 1942 = Season closed (not yet reopened)

Nebraska

(Vodehnal 1999)

By most accounts chickens were not abundant in much of Nebraska prior to the 1850s.

- Early chicken populations bound to small farms at Indian village sites
- 1863 = Homestead Act played a major role in the future of chickens in Nebraska
- By late 1860s = settlers opened many small fields in the grassland sea and chicken numbers exploded; birds became a staple in settlers' diets and the railroads brought market gunning
- 1874 = 300,000 chickens were shipped to market from 30 eastern counties; birds brought $4/dozen
- Late 1800s = Peak numbers of chickens
- 1930s = Lowest numbers of chickens
- Prairie grouse hunter numbers = 7,000+ in 1950s; 20,800 in 1973; 13,000+ in 1990s
- 1950s to present = Prairie chicken populations more closely managed and annual season held (typically with 2–3 bird/day bag limits)

North Dakota

(Johnson and Kane 1989)

- Chickens came into North Dakota Territory in the early 1880s, eventually residing in most of the state except the Badlands.
- 1897 = In October, a hunting party from Massachusetts occupied a private train car at Dawson where they received the best

of everything during their 30-day chicken hunting trip at, a cost of $200/person

- 1929-30 = Charles Wenz of New Rockford recalled that his family and many others survived those 2 drought/depression years by eating prairie chickens and jackrabbits; H.B. Spiller in Dickey County, said his family tired of eating prairie chickens but ate them rather than butcher their domestic chickens
- 1930s = Most hunters agreed: September was the best time to hunt for prairie chickens
- 1938-42 = The only years there are harvest estimates for prairie chickens; hunters averaged 39,400 birds during those years
- 1945 = Last season for prairie chickens (not reopened yet)

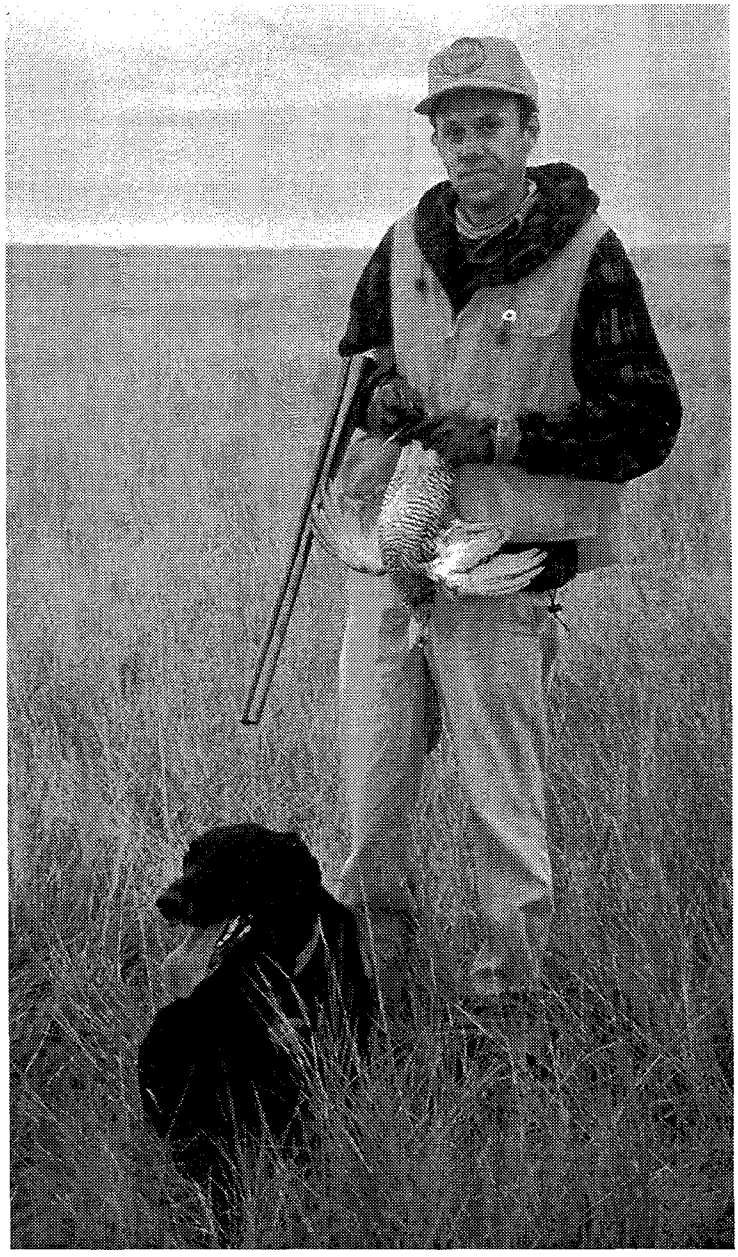

Figure 3. Chicken hunting on South Dakota grass.

Oklahoma

(Horton and Wolfe 1999)

In 1959, a license to hunt chickens was $2 plus a $1 permit; the season was 2 days with a bag of 2 birds/day.

- Greater/lesser prairie chicken harvest = low of 671 in 1996; a high of 9,651 in 1982
- Chicken hunter numbers were highest in 1960s with 14,000 hunters
- Season is now closed for both species of prairie chickens

South Dakota

(Fredrickson et al. 1999)

Most birds are thought to have "come in with the settlers" in 1870s.

- 1870–1900 = Years of heaviest harvest (market/subsistence)
- Prairie grouse harvest varied greatly; a low of 64,300 in 1977 and a high of 174,300 in 1979
- Annual average harvest of chickens falls to between 4,000–6,400
- Prairie grouse hunters numbers have held steady at 20,000–25,000

In the present era, one has to be overjoyed just to get the occasional chance at these grand gamebirds. In my opinion, chicken hunting is being in the "big-wide open," walking prairie landscapes so immense that even those with the greatest human egos will feel humbled. Chicken hunting is the chance to meet other prairie inhabitants; fellow creatures of the grassland sea such as pronghorns, mule deer, short-eared owls, peregrine falcons and prairie rattlesnakes. Chicken hunting is setting-up grouse camp in places where the Red Gods liberally paint the sky with unforgettable washes of reds and yellows. Chicken hunting is being with best friends and a hot meal after a long day of walking crisp, prairie air. Chicken hunting is that moment when miles of walking and good dogwork reward you with a bird or better yet, seeing excellent dogwork followed by a fine wingshot by your hunting partner (Fig. 3). Chicken hunting is sometimes saying goodbye to old canine friends and then starting anew with a young pup. Chicken hunting is the scent of gun powder in chilly, clean air and sometimes plump birds for supper. Chicken hunting is admiration and deep respect for your quarry. Chicken hunting is a rest on a prairie knob with your best friends and maybe some weight in your gamebag.

When I talk to the Red Gods, I often ask that there be more moments such as these for those of us who have a spiritual bond with the great pinnates and the grand places in which they live.

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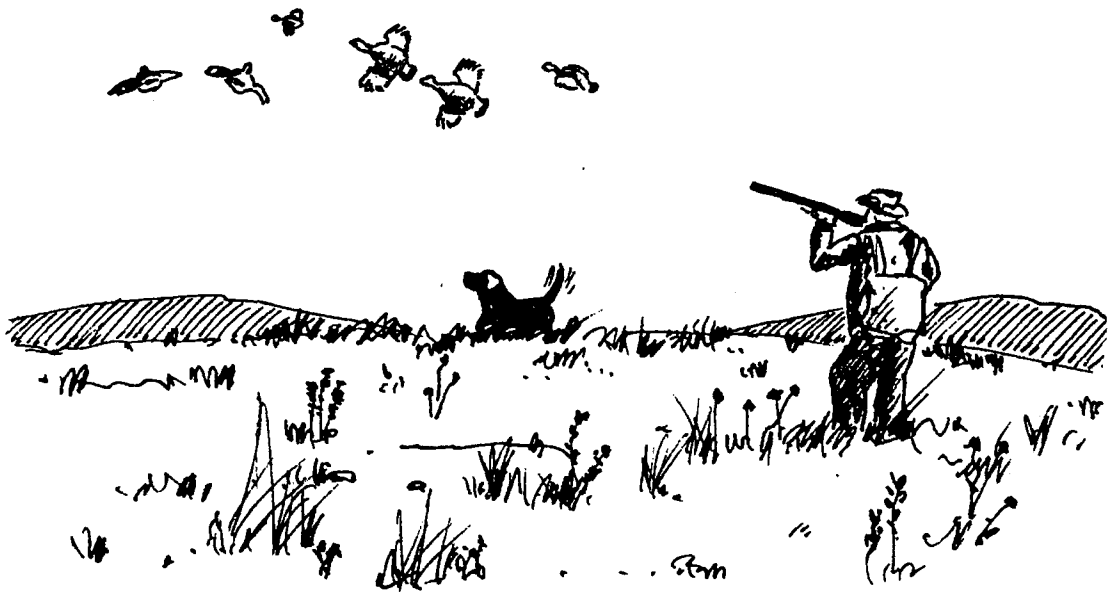

National Outlook and Conservation Needs for Greater Prairie Chickens

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Past rangewide appraisals of the status, outlook, and needs of greater prairie chickens (*Tympanuchus cupido pinnatus)* include those by Hamerstrom and Hamerstrom (1961, 1963), Christisen (1969), Westemeier (1980, Westemeier and Edwards (1987), Gough (1990), and Schroeder and Robb (1993). Since then, changes in human pressures, farm legislation, habitat quality, and translocation techniques for greater prairie chickens have been steadily developing. As intensified land use causes habitat loss, wildlife declines are being registered on many fronts, with recent Breeding Bird Surveys indicating problems of particular concern for grassland species. Conversely, new farm bill legislation requires Conservation Reserve Program (CRP) lands to provide more benefits to wildlife, and offers incentives and cost sharing programs such as Wildlife Habitat Incentive Program (WHIP) and Environmental Quality Incentive Program (EQIP) for habitat development projects (Gough 1998).

The various grassland restoration projects can play significant roles in providing habitat for grassland-dependent species. Another dynamic affecting the prairie chicken's status is improved prospects for success with translocations as documented in several states. All of these changes precipitate the need for new information.

This paper updates and summarizes the status, outlook, and needs of greater prairie chickens in the 11 states where the species occurs. We include information on translocations made for purposes of reintroduction, demographic and genetic enhancement, and public enjoyment. We emphasize management-oriented information because that is the most critical need of greater prairie chicken managers throughout the range.

Methods

Much of the information in this paper was provided by responses to a mailed questionnaire originally developed by Christisen (1969) and modified by Westemeier (1980). In addition to general coverage of the 11 states with populations of greater prairie chickens, we sought information for selected preserves, refuges, ranches, and other grasslands. Abundance estimates are based on spring booming ground surveys using cock counts, or fall populations using booming ground surveys plus age ratios from harvest data (e.g., Vodehnal 1999). Hunter reports are notoriously biased (Keith 1963). For the 4 states with hunting seasons, prairie chicken distributions were so extensive that estimates of abundance were at best, educated guesses. We used the most liberal estimates given for

each state. A 50:50 ratio of both sexes was assumed for spring counts of males, doubling the count to estimate abundance. The sex-ratio assumption may not be valid; hence, one may divide by 2 to determine the count of males. Our mention of 10-year cyclic tendencies of prairie chickens "is used with no connotation of strict regularity" (Keith 1963:118). We also reviewed the most current literature available from each state for additional information.

Results and Discussion

ABUNDANCE & DISTRIBUTION OF UNHUNTED POPULATIONS

Colorado — Current estimate of abundance (1997) is 10,000 prairie chickens (Giesen and Schroeder 1999), which continues an increasing trend from 760 in the 1960s, 3,000–6,000 in 1983 (Van Sant and Braun 1990); and 6,000–8,000 in 1989 (K. Giesen in Gough 1990) (Table 1). When the species was declared endangered in 1973, only 1 distinct breeding population was known in Colorado "and it occurred almost exclusively on private land" (Hoffman et al. 1992:197). This information amends estimates reported by Evans (1963) in Christisen (1969:209, "7,600" birds) and by Schroeder and Robb (1993:20; "no change . . . during the last 25 years").

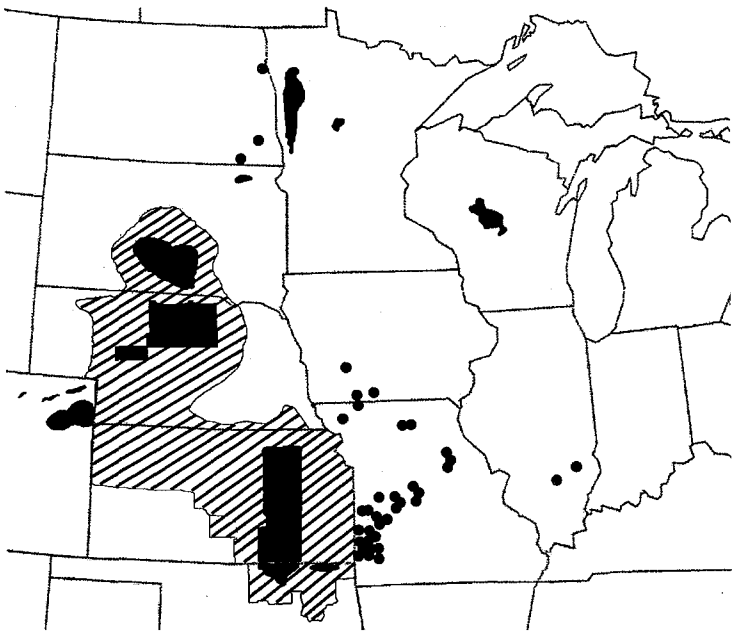
Currently, the main range occurs in Yuma and Washington counties, but smaller populations exist in 5 other northeastern counties (Fig. 1) as a result of transplants. The Tamarack Area transplants were particularly successful, as at least 15 booming grounds were noted on or nearby the 4,714 acres (1,907 ha) of restored native grasses (Hoffman et al. 1992).

The outlook in Colorado is for stable to increasing numbers. The disjunct arrangement in the amount of "irrigated corn to rangeland in a configuration that allows greater prairie chickens to take advantage of both" is considered the limiting factor (M. Schroeder, personal communication).

Illinois — The current spring estimates were 168 prairie chickens in 1997 and 256 in 1998, both of which indicate population increases up from near extirpation, when only 46 native birds were counted in spring 1994 (Westemeier et al. 1999). Genetic defiencies were evident in these Illinois remnants (Bouzat et al. 1998a,b) and their fitness, as based on declines in egg fertility and success, had also declined (Westemeier et al. 1991, 1998a). Translocations totaling 518 birds from Minnesota, Kansas, and Nebraska were made from August 1992 through April 1998 to demographically and genetically enhance remnant populations.

The range is mainly limited to parts of Jasper and Marion counties (Fig. 1) with about 1,400 and 700 acres (567 and 283 ha), respectively, of intensively managed sanctuary grasslands, and very little CRP grassland. An exception was a confirmed boomer in 1997 and 1998 near Hunt City in northeastern Jasper County where the late Ralph Yeatter conducted his studies in the 1930s (Yeatter 1943). Other confirmations were in Effingham and White counties. New populations are possible from the translocations because CRP grasslands

Figure 1. Greater prairie chicken range in 1997 with larger black areas depicting main ranges. Small dots and crosshatching depict more localized populations.



exist considerably farther south of this range. The outlook is guardedly optimistic in Jasper County where new managed grasslands (Westemeier 1997), successful control of pheasants (*Phasianus colchicus*) (Westemeier 1988; Westemeier et al. 1998b) and nest predators, an enhanced gene pool, and apparent restoration of egg viability (Westemeier et al. 1998a) are positive factors – at least for the short term.

Iowa – The current estimate (1997) was 100-200 prairie chickens in contrast to virtually none between 1955-86. The most current translocations began in 1987 and ended in 1994 with a total of 549 birds released (Moe 1999). The confirmed range includes parts of Ringgold (mainly), Adair, and Decatur counties (Fig. 1). Prairie chickens may be using parts of 4 other southwestern counties. The outlook is optimistic for the next 10 years because of a good CRP signup in those counties and the prospects of increased grassland habitat that will result from the proposed Kellerton Bird Conservation Area. Success with prairie chickens in Ringgold County can be partially linked to a well-managed native prairie pasture of 1,200 acres (486 ha) in Missouri (McMillen 1998). Other tracts of CRP and managed grasslands in northwest Missouri have positively influenced Iowa's prairie chicken restoration efforts (Moe 1999).

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

State	1968[a]	1979[b]	1985[c]	1989[d]	1997
Unhunted populations					
Colorado	760	3,000	6,000	8,000	10,000
Illinois	300	230	300	68	168
Iowa	0	0	0	?	200
Minnesota	5,000	2,000	1,600	2,000	1,868
Missouri	10,000	9,600	6,000	3,000	1,000
North Dakota	1,800	1,000	800	?	300
Wisconsin	1,000	1,842	1,354	1,200	1,222
Hunted populations					
Kansas-total	750,000	200,000	1,000,000	1,000,000	178,000[e]
Kansas-harvest	46,000	40,000	54,000	53,000	16,000
Nebraska-total	100,000	200,000	200,000	200,000	131,484[f]
Nebraska-harvest	15,000	8,200	5,000	35,000	?
Oklahoma-total	130,000	80,000	?	12,000	1,500
Oklahoma-harvest	14,000	8,000	5,000	?	<200
S. Dakota-total	80,000	40,000	?	?	65,000
S. Dakota-harvest	10,000	5,233	4,000	?	8,000

[a] *Christisen 1969 (estimate for Colorado amended).*

[b] *Westemeier 1980 .*

[c] *Westemeier and Edwards 1987 (Colorado estimate for 1983 from Van Sant and Braun 1990; Kansas estimate is for 1982).*

[d] *Gough 1990.*

[e] *Derived estimate — see text.*

[f] *Estimate for Sandhills only.*

Minnesota — Since 1974, Minnesota prairie chickens have shown 2 strong peaks in abundance, spaced 10 years apart, with the last high (1992) showing 3,826 birds (Wolfe 1997). The most current estimates are 1,868 (1997) and 2,924 (1998) prairie chickens (Wolfe 1999). Whether or not the peaks in numbers are statistically significant, they at least appear to be convincing evidence for a 10-year cycle. The occupied range includes parts of 11 northwestern and north central counties. The outlook is optimistic, owing to 80,972 acres (32,769 ha) of grassland habitat owned by the Minnesota Department of Natural Resources (MNDNR) (49%), the U.S. Fish and Wildlife Service (39%), and The Nature Conservancy (TNC) (12%), all of which are managed at least in part for prairie chickens. Moreover, CRP grasslands within the prairie chicken range total 148,260 acres (60,000 ha), nearly twice that of the public grasslands (Svedarsky et al. 1997).

Missouri — The 1997 estimate for resident prairie chickens is 1,000 birds (Mechlin 1999), a stark contrast to the 10,000 birds estimated in 1967 (Table 1; Christisen 1969). Worse, the trend over the past 28 years indicates they will be gone by 2009; the last 7 years suggest extirpation by 2002 (Mechlin 1999)! On a more hopeful note, birds associated with public prairies are not declining as rapidly as those depending solely on private land. Also, reintroduced populations in north Missouri have shown relative stability, with the 1997 survey reporting 22 males in Harrison County, 57 males in Sullivan County, and a new confirmed booming ground in Nodaway County.

Missouri's chickens occur in 21 counties mostly in the southwest and westcentral part of the state (Fig. 1). Public grasslands with potential for chickens total about 21,000 acres (8,500 ha). Thus, although the current outlook is alarming, a series of years with good weather for reproduction could turn things around as occurred for continental waterfowl numbers. Improved weather for hatching and early brooding have resulted in more and bigger broods being reported on several Missouri prairies in 1997 and 1998.

Recent land acquisitions may have favorable impacts on local flocks. The Nature Conservancy (TNC) continues to expand its grassland acreages in Missouri. The owners of Dunn Ranch, a 1,200-acre (486 ha) native prairie in Harrison County (northwest Missouri), are negotiating with TNC for sale of the ranch. Prairie chickens associated with Dunn Ranch are linked with releases of chickens in nearby Iowa.

North Dakota — The current statewide estimate (1997) was 300 prairie chickens (Kobriger 1999). The Sheyenne Grasslands in Ransom and Richland counties, because of their size (134,788 acres [54,548 ha]), 52% under Federal administration and 48% private land), should have the greatest potential for chickens. A "density of 16 male prairie chickens per square mile" (/259 ha) or about 1,600 males is a realistic goal for "100 square miles of potential prairie chicken habitat . . . in the Sheyenne National Grasslands (Manske and Barker [1981] in Kobriger et al. 1988:4). However, only 69 males were counted there in 1997 in contrast to 410 males in 1982 (Kobriger 1999).

Reintroductions resulted in 53 males (minimum count) on the Bry Area in Grand Forks County. Six males were found in Sargent County. A management objective for North Dakota was to establish 3 viable populations by 1995 on the Sheyenne, Grand Forks, and Englevale areas, with releases augmenting establishment efforts on the latter 2 areas. The Englevale release of 1993 appears unsuccessful. This failure, coupled with an overall downward trend in numbers, creates a poor outlook for North Dakota.

Wisconsin — The 1997 estimate was 1,222 prairie chickens, based on a count of 611 males; and similar counts in 1998 (J. Keir, T. Meier, J. Toepfer, University of Wisconsin-Stevens Point, and others, personal communication). Buena Vista Grasslands continued to be the stronghold with 324 males. Significant counts of males were reported for the Leola Grasslands (97), Paul Olsen Area (100), Mead (60), and the north range (30) areas as well.

Survey numbers suggest 10-year cycles, simi-

lar to Minnesota's, with a strong peak of 550 males on Buena Vista in 1981-82 (Anderson and Toepfer 1999) that matched 1950-51 counts. Counts on Paul Olson (302 cocks) and Mead areas were also at peak levels in 1981 (or nearby years), bringing 1981's total to 1,121 cocks in the known range. Importantly, the current range is likely interconnected (Hamerstrom and Hamerstrom 1973: 28-29), including 6 counties and extending over 75 miles (120 km) in length (Fig. 1).

The outlook is that the current level of management on 16,000 acres (6,475 ha) will maintain prairie chickens in Wisconsin (Keir 1999). This is based on counts during the 1990s, which through 1998, have ranged between 300-421 cocks on the most-intensively managed areas (Buena Vista and Leola combined). In contrast, counts on the same areas in the 1960s were as low as 132 cocks (1969) when drought, brush clearing on management lands, and intensive farming on private lands were factors (Hamerstrom and Hamerstrom 1973). Should public policy dictate, expanded management could increase not only overall numbers, but long-term population security as well. Cranberry production, however, presents a relatively new threat on Buena Vista Grasslands.

ABUNDANCE & DISTRIBUTION OF HUNTED POPULATIONS

Kansas — A current estimate of abundance was unavailable, but the statewide distribution includes all but the southwestern counties and half of the southcentral counties (Fig. 1). Populations in the occupied portion of the state are thought to be contiguous or nearly so (R. Applegate, personal communication). In 1989, the estimate of total birds ranged from 200,000 to as high as 1 million, with a hunter harvest of 53,000 greater prairie chickens (K. Church in Gough 1990). Dividing that harvest by a median estimate of total birds (53,000/600,000) yields a 9% harvest rate. If that harvest rate applies to the 1996 estimated harvest of 16,000 birds, prehunt populations would have totaled about 178,000 birds in 1996 (Table 1). The 1996 harvest was the second lowest on record, tying with that reported in 1975. In contrast, the 1982 harvest was estimated at 109,000 greater prairie chickens. Apart from a slight recovery in 1997, since 1982, the trend based on booming ground surveys has been downward in all 4 regions, including the prime Flint Hills range (Applegate and Horak 1999). Annual burning, coupled with widespread, early intensive grazing, impacts nest success and probably brood-rearing success as well. With no significant areas under management for chickens, the outlook for Kansas is uncertain, at best.

Nebraska — The main range of prairie chickens in Nebraska includes the eastern and southern periphery of the Sandhills where abundance was estimated at 131,484 in 1996 (Vodehnal 1999). The overall distribution is thought to include all of central Nebraska, overlapping the entire boundary with Kansas, the center of the boundary with South Dakota, and the northeast corner of Colorado (S. Taylor and W. Vodehnal, personal communication; Fig. 1). This distribution includes localized populations in fragmented habitat outside the Sandhills range. Based on booming ground surveys between 1982-97, abundance appears to be relatively stable (Vodehnal 1999). Current numbers may be at least similar to 75,000-200,000 birds reported in 1979 (Westemeier 1980); and to 150,000-200,000 reported in 1985 (W. Vodehnal in Westemeier and Edwards 1987) and 1989 (W. Vodehnal in Gough 1990). The annual harvest estimate in 1989 was 35,000 chickens, well above estimates of 15,000 and 8,200 in 1967 and 1977, respectively (Westemeier 1980). Thus, the outlook is for relatively stable populations.

On federal refuges in Nebraska, the most significant hunted population occurs on the Valentine National Wildlife Refuge (NWR) where 269 males were counted on 33 booming grounds in 1997 (L. McDaniel, personal communication). From 1988 through 1994, counts at Valentine ranged from about 400 to more than 500 booming males, with a peak of 538 in 1991 (McDaniel 1989; Svedarsky and Van Amburg 1996). The recorded hunter harvest on Valentine NWR was 136 chickens in 1991, even though grassland management is not directed specifically toward prairie chickens.

(Sharptails [*T. phasianellus*] are the principal prairie grouse taken on Valentine Refuge.) Few if any prairie chickens occur on Fort Niobrara and Crescent Lake NWRs.

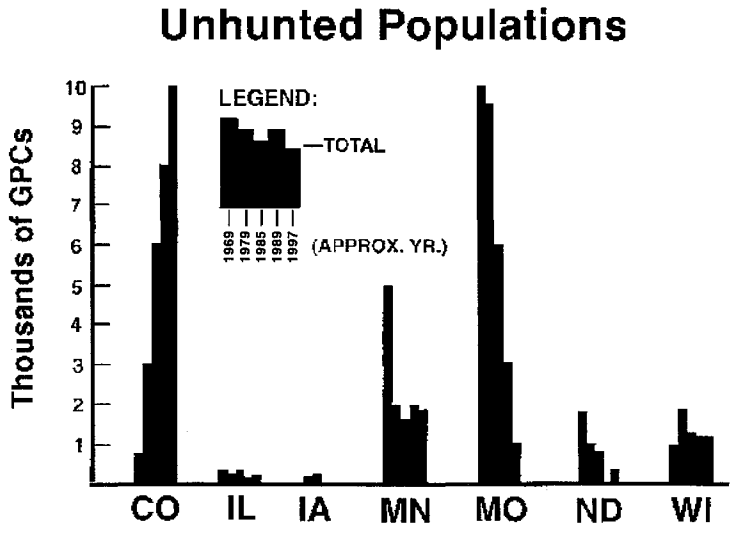
Oklahoma — A current estimate of prairie chicken abundance was 1,500, or about 1% of the 130,000-bird reported for 1968 (Table 1). Recent surveys indicate that greater prairie chickens occur in 11 northeastern counties (Horton and Wolfe 1999) (Fig. 1). Total abundance was estimated at 10,000–12,000 birds in 1989 with optimism that populations would remain steady (R. Horton in Gough 1990). However, the trend has been downward since 1979, and especially since 1990 (Horton and Wolfe 1999). The 1997 hunter harvest likely comprised less than 200 birds. Thus, the hunting season on prairie chickens will be closed for a minimum of 4 years beginning in fall 1998. Despite the grim trend in numbers, the outlook for greater prairie chickens in Oklahoma is stability, with hopes for a steady (although likely quite slow) increase.

The Nature Conservancy's new Tallgrass Prairie Preserve in Osage County offers long-term promise for Oklahoma prairie chickens because of its size (38,000 acres [15,378 ha]) and commitment to management. Current estimates (1991–97, except 1992) of prairie chicken numbers range from 58 males on 8 leks to 126 males on 15 leks (R. Hamilton, personal communication). Initial management on this large, unhunted tract included controlled burns of up to 6,000 acres (2,428 ha) and grazing with 300 bison on 5,000 acres (2,023 ha) (Ackerman 1993, Hamilton 1996).

South Dakota — Total abundance for 1997 was estimated to be between 60,000 and 65,000 prairie chickens, with an estimated harvest of 8,000 birds (harvest rate equals 12–13%) (G. Heismeyer, personal communication). While this harvest was not as high as that of 1967 (10,000; Christisen 1969), it doubled the 29-year annual harvest average of 4,000 birds (L. Fredrickson in Gough 1990). In 1996, Fredrickson et al. (1999) estimated the prairie chicken harvest at 10,900. The main range occurs in the south central counties of Lyman, Brule, Buffalo, and Gregory, and in portions of 8 other counties. Localized populations occur in 14 additional counties (Fig. 1). CRP grasslands have increased prairie chicken abundance and distribution over the past 10–15 years. Many of the significant CRP contracts in southcentral South Dakota are reverting back to agriculture. However, these losses may be counteracted by increased CRP acres in eastern counties that may enable prairie chickens to continue expansion in that direction. The outlook is for declines in some areas and significant potential for expansions in others.

Outlook Summary — Although greater prairie chickens are distributed over 11 states, their status varies greatly from state to state. Illinois populations are probably most endangered because of their small size, isolation, and relative lack of supporting grasslands. Populations in Iowa and North Dakota are similar in size to Illinois flocks (Fig. 2), but the birds and grasslands of Iowa are linked to those in Missouri; and possibly to those of Nebraska and Kansas (Fig. 1), giving these populations potential avenues of expansion. North Dakota prairie chickens and grasslands seem reasonably close to Minnesota and possibly South Dakota flocks, but they probably are not

Figure 2. Estimates of population size of greater prairie chickens in 7 states without current hunting seasons including Colorado, Illinois, Iowa, Minnesota, Missouri, North Dakota, and Wisconsin during 5 approximate years from 1969–97.



close enough for significant interchange. Unlike the situation in Illinois, some connectivity of populations seems a possible feature in these 4 states. Whether such connections are sufficient to provide demographic and genetic rescue remains questionable. Current downward trends in numbers appear most serious in Missouri, Oklahoma, North Dakota, and possibly even Kansas (Table 1, Figs. 2 and 3).

Relative stability seems to exist in Nebraska, South Dakota (Fig. 3), Minnesota, and Wisconsin (Fig. 2), notwithstanding several strong peaks suggestive of cyclic tendencies during some of the years ending in 0, 1, or 2 in the latter 2 states. The steady upswing in Colorado (Fig. 2) portends a bright outlook for prairie chickens there, especially with a landscape ratio of 84% rangeland (20% classed as "good quality") and 13% cropland, especially corn (Schroeder and Braun 1992). However, with most birds occurring on private land, Colorado prairie chickens could be in trouble if land-use patterns follow those of Kansas and Oklahoma.

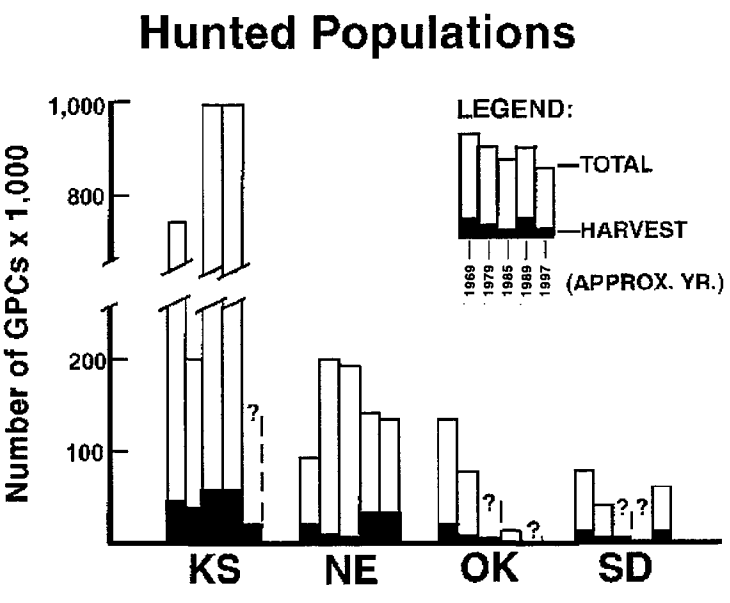
CONSERVATION NEEDS

Minimum Viable Populations (MVP) — Estimates by conservation biologists of the number of individuals of a species that constitutes a minimum viable population have ranged from 50–500, the latter allowing for evolutionary processes to continue (Franklin 1980, Schaffer 1981, Simberloff 1982, Brussard 1985). Matings by closely related individuals lead to decreased heterozygosity, causing small populations to lose fitness and become less fecund and vigorous (Westemeier et al. 1998a). Geneticists studying fruit flies (*Drosophila melanogaster)* calculate that 5,000–10,000 or more individuals might be needed to ensure long-term species survival (Lande 1995). Alternatively, it can be speculated that prairie chickens are adapted for inbreeding because of their lek breeding system.

Toepfer et al. (1990:575) reported historical evidence suggesting "that once prairie grouse fall below 100 cocks . . . [200 total birds] . . . they will eventually disappear without habitat improvement or acquisition." Attwater's prairie chickens (*T. c. attwateri*) showed a steady upward trend (1973–87) from about 40–100 males on the Attwater's Prairie Chicken NWR, but when the decline in surrounding off-refuge numbers brought the total males to under 250, that population dropped to near extinction (Morrow et al. 1996). Yet, prairie chickens on the Sheyenne Grasslands in North Dakota declined to extremely low numbers (3–9 cocks) in the 1960s and rebounded to 410 males by 1980 (Kobriger et al. 1988). Similarly, isolated prairie chickens in Audrain County, in eastern Missouri have persisted at low numbers for several decades (Christisen 1985), and continue to do so.

Many existing isolated populations are likely doomed if >200 prairie chickens are indeed necessary for long-term viability. This would include most present reintroduced populations and even those on large prairies like the Sheyenne Grasslands and Oklahoma's Tallgrass Prairie Preserve. Scenarios of heath hens (*T. c. cupido*) on Martha's Vineyard, Attwater's prairie chickens in Texas (Silvy et al.

Figure 3. Estimates of population size of greater prairie chickens in 4 states with current hunting seasons including Kansas, Nebraska, Oklahoma, and South Dakota. Black portions of bars depict hunter harvest estimates and open bars depict estimates of population totals during 5 approximate years from 1969–97.



1999), greater prairie chickens in Illinois, and probably elsewhere, suggest failure if numbers are not increased and maintained above the 100-cock lower limit suggested by Toepfer et al. (1990). In this regard, population sizes in Minnesota for 2.5 decades and Wisconsin for 5 decades are encouraging. These suggest that self-contained ("closed") populations with ≥250 (Wisconsin) to ≥500 males (Minnesota), even through possible cyclic lows (with similar numbers), may be adequate MVPs.

So far, it does not appear that the numbers of chickens in either Minnesota or Wisconsin are too few to keep these populations viable. If adequate booming ground surveys can be continued, the Wisconsin data may provide the best insight into what a MVP for prairie chickens should be. The Wisconsin counts are not only longest term, they are of high quality, and they provide the lowest closed-population size that appears to be maintaining reasonable long-term stability. The emerging value of these data underscores the critical importance of good spring counts.

Habitat Needs — The literature is replete with conclusions emphasizing the need for adequate grassland suitable for successful nesting and brooding as the most critical rangewide need for greater prairie chickens (e.g., Hamerstrom et al. 1957, Kirsch 1974, Wisdom and Mills 1997). Also, all states emphasized the need for grassland habitat with suitable structures to meet the needs of the species year-round. Kansas, for example, has vast native grasslands but annual burning of entire pastures (even entire landscapes horizon to horizon) and early intensive grazing does not provide residual vegetation for nesting prairie chickens (Applegate and Horak 1999). The productivity of prairies under such intensive land use is in jeopardy, and the sustainability questionable even for livestock production. At the other extreme, vegetative litter (i.e., horizontally-oriented residual cover) exceeding 25% at nest sites may result in nests failing at twice the rate of nests with <25% litter (McKee et al. 1998). Managers must seek a "happy medium" in litter cover for nesting prairie chickens. Moreover, too many preserved prairies are being set aside as "museum specimens" with fall burning the only management approach. Such prairies sometimes involve very large tracts (S. Clubine, personal communication).

Another consideration is the juxtaposition of crop areas that provide concentrated feeding sites. Optimally, about 20–30% of the landscape should be in crops (especially corn), to provide winter food, and balance year-round needs for prairie chickens. Too little corn, in concert with overgrazing and annual burning, may limit prairie chicken distribution in portions of all grasslands of the Great Plains. At the other extreme, Illinois has vast croplands but far too few suitable grassland acres.

How much grassland is enough? The quantity of grassland needed depends on the densities of prairie chickens that realistically can be attained. Densities vary greatly throughout the species' range. For nearly 2 decades, a density of 100 males/square mile (39 males/km^2) of managed grassland appeared to be realistic in Illinois (Westemeier 1980, 1997). Such a goal was proposed for prairie chickens by Kirsch (1974). Unfortunately, land acquisition goals were not attained in Illinois, other negative factors intervened, and high densities did not continue into the 1990s.

Estimates derived by the Toepfer model (Toepfer et al. 1990) suggest a need for about 4,000 acres (1,619 ha) of suitable grassland to sustain a population containing 200–250 prairie chicken cocks. The estimate from this model was based on research in Minnesota and Wisconsin conducted on range acquired after European settlement, that is, not the species' original range (Hamerstrom and Hamerstrom 1963:884). Application of the same formula to Illinois data (using means for inter-booming ground distances and cock numbers per booming ground) suggests that only 1,500 acres (607 ha) may indeed be significant on Illinois' original prairie chicken range. This quantity of grassland is a minimum, that assumes managed grasslands are well situated, properly managed, and well utilized by prairie chickens. Several other estimation approaches, suggest a need for several thousand acres (e.g., 4,000 acres [1,619 ha]; Westemeier, unpublished data). If management addresses other threatened and endangered

grassland species, 1,500 acres is far too little grassland (Simpson and Esker 1997).

Intensive management of 13,000 acres (5,261 ha) on Wisconsin's Buena Vista and Leola Grasslands maintained 300–421 cocks during the 1990s (Anderson and Toepfer 1999, J. Keir, personal communication). This is well above Toepfer's minimum limit of 100 cocks (Toepfer et al. 1990), and an excellent density of 15–21 cocks/square mile (5.8–8.1 cocks/km^2) of managed grassland. The density of 16 cocks/square mile (6.2 cocks/km^2) (Manske and Barker [1981] in Kobriger 1988:4) seems equally feasible for the Sheyenne Grasslands in North Dakota.

Thus, the area of suitable grasslands required to support a minimum viable population, assuming it is well-sited and used by prairie chickens, may range from a minimum of 1,500 acres (607 ha) in Illinois to 13,000 acres (5,261 ha) or more in the northern and western range, to support a minimum viable population. If the ratio of nesting and roosting cover to brooding cover should be 50:50, these area estimates may need to be doubled, as nesting and roosting cover often differs greatly from quality brood cover. Moreover, brood cover should be adjacent to nest cover and both should be within 1–2 miles (1.6–3.2 km) of booming grounds (Svedarsky and Van Amburg 1996).

The above requisites for prairie chicken habitat must occur within "large areas of open country — wide horizons" (Hamerstrom et al. 1957:11). High-rainfall states are struggling with the encroachment of trees and brush into existing grasslands. A Missouri Department of Conservation study estimated that Missouri gained 1 million acres (404,694 ha) of trees in a 17-year time span, most of which occurred along fencerows and draws. The new treelines have severely fragmented grassland habitat, eliminating vistas and adding the type of habitat preferred by raccoons (*Procyon lotor*) and other mammalian predators.

Unfortunately, large areas of habitat do not necessarily guarantee preservation of prairie chickens. In Texas, Silvy et al. (1999) report extirpation of Attwater's prairie chickens (APC) in sizeable areas that appear to offer all the requisites to support APC. Other decimating factors in Texas apparently include reduced environmental quality, infectious agents, inbreeding, and environmental stochasticity.

Management Needs on Manageable Land — The importance of adequate booming ground surveys cannot be overemphasized. Without them "there is no way to biologically measure the effectivness of management actions" (Svedarsky and Van Amburg 1996:93). Long-term survey efforts in Minnesota and Wisconsin are especially important because they may provide the best estimates of what the size of minimum viable populations should be for greater prairie chickens. Moreover, "booming grounds are an important reference point for management and an essential orientation and breeding center for prairie chickens" (Svedarsky and Van Amburg 1996:94). Prairie chicken managers should be keenly aware of the locations of all booming grounds on/near lands under their charge and strive for optimum habitats for nesting, brooding, and roosting within 1–2 miles (1.6–3.2 km) of the booming grounds (Hamerstrom 1957, Westemeier 1971, Hamerstrom and Hamerstrom 1973, J. Toepfer in Svedarsky and Van Amburg 1996). Management for booming grounds per se should not be "just a little hole in the weeds. It would be well to mow about 40 acres with the booming ground in the center" (Hamerstrom et al. 1957:48). In Illinois, sites 10 acres (4 ha) in size, mowed, burned, disked, or in soybean stubble, and available to the birds in early fall, have worked well for booming grounds.

Management emphasis within close proximity of booming grounds is most pertinent and feasible when land control is attained by governmental or corporate agency ownership. A 4-year rotation of prescribed burning, late high mowing, late haying, or light grazing, and various rest-rotation schemes seems to be (or should be) standard approaches to grassland maintenance for prairie chickens. Rotations may be lengthened to 6 years on droughty sandy soils or on peat soils subject to peat fires. Visual obstruction readings (VOR, Robel et al. 1970) provide useful measurements of

grassland height and density for prairie chickens. The aim should be to have at least 50% of spring residual grasslands around key booming grounds measuring *100% VORs at 8 inches (2.0 dm) or slightly more* for nesting and roosting. Fields intended for brood cover can be essentially bare at the beginning of the growing season, but they should provide screening with VORs measuring 8–16 inches (2–4 dm), an abundance of grasshoppers, and ease of movement for broods by hatching time.

Current references with excellent prescriptions for habitat management for prairie chickens include Svedarsky and Van Amburg (1996), Toepfer *in* Svedarsky and Van Amburg (1996), Svedarsky et al. (1997), and McKee et al. 1998). Recommendations by Rice and Carter (1982) for rest-rotation and winter grazing are especially appropriate for prairie chickens in South Dakota and the Great Plains in general.

Other management needs may include tree and brush removal, control of invasive exotic plants (particularly tall fescue *Festuca elatior var. arundinacea*] in Missouri and Illinois, sericea lespedeza [*Lespedeza cuneata*]in Kansas, Oklahoma, and Missouri, and leafy spurge [*Euphorbia esula L.*] in North Dakota), nest predators, pheasants, and a myriad of other problems associated with maintaining quality grasslands. A laissez-faire management philosophy will not save prairie chickens.

A Management Approach on Private Lands — Given the increasing opposition to government or agency ownership of land in Missouri, the Missouri Department of Conservation has developed a private land program called "Partners for Prairie Wildlife" (PPW). This project was developed to find out if grassland management practices could be promoted on private lands sufficient to improve the survival outlook of prairie chickens and other grassland species. Two project areas were selected of about 40 square miles (104 km^2) each. These were chosen based on the presence of core habitat on public lands, a history of good cooperation with area landowners and related agencies, relatively healthy prairie chicken populations, and the presence of ample grassland resources on private lands. Objectives of the program were to: (1) Enhance grassland diversity and structure so that suitable nesting and brood-rearing habitat for prairie wildlife is distributed over 40% of target areas; (2) Reduce fragmentation of the prairie landscape by removing invasive trees from prairie soils that obscure vistas and contribute to reduced nesting success due to predation; and (3) Demonstrate to landowners that forage production and habitat improvement for prairie wildlife can be compatible. Ten practices (with incentives) were offered to landowners:

1. *Convert fescue to native warm-season grasses ($55.00/acre).*
2. *Convert fescue to alternative cool-season grasses (not fescue) and legumes (herbicide only).*
3. *Control introduced cool-season grasses in native prairie (herbicide).*
4–6. *Overseed lespedeza into existing stands of cool-season grasses, planted warm-season grasses, or small grains ($12.00/acre).*
7. *Rest prairie ($25.00/acre).*
8. *Implement rotation grazing ($4.00/acre).*
9. *Restore prairie wildlife habitat fragmented by tree invasion (MDC pays all costs associated with tree removal in areas where prairie species gain ≥20 acres of "open" grassland for nesting.*
10. *Fence replacement for fence damaged during removal of trees ($0.25/lineal foot).*

A recent progress summary tallied over 90 miles (144 km) of treelines removed. Tree removal was by far the most popular incentive because it often entailed fence replacement. It was also the most expensive. However, contracts required 10 years of tree-free maintenance. Tree removal opened up about 1,400 acres (567 ha), at a cost of $59,000. Spaced over the 10-year contract period the

cost is $4.20/acre (10.38/ha) /year. All practices were used at least once by cooperators in Missouri's PPW program. It is expected that it will take several years before desired responses are discernible.

Tree removal enhances the open space for prairie wildlife and reduces predator dens and raptor perches. It is also part of various open space enhancement efforts in Illinois, Iowa, and Wisconsin.

Other Management Approaches — Native warm-season grass (NWSG) plantings that are not managed do not make suitable nesting or brood-rearing habitat [for prairie chickens] in the tallgrass prairie regions where soil fertility and rainfall are high (S. Clubine, personal communication, Westemeier and Buhnerkempe 1983, Westemeier et al. 1995). Incorporating NWSG plantings into low-to-medium-grazing systems that leave 8–10 inches (20–25 cm) of growth throughout the summer is a good management option. Overseeding pasture with alfalfa, Korean lespedeza (*Lespedeza stipulacea*), and/or native forbs adds to their value for brood rearing. Haying NWSG only once in July, at about 4–6 inches (10–15 cm), will keep stands vigorous and allow for ample regrowth for roosting, and perhaps for nesting the following spring. CRP tracts should be high-mowed 8–10 inches (20–25 cm) in July and allowed to regrow to 18 inches (46 cm) by frost, to provide optimum cover height for wintering and nesting (Gough 1997). Legumes or native forbs should be introduced as well to increase diversity of both structure and food sources. Both CRP and other grasslands should have periodic fire, taking care to rotate the burns to avoid eliminating nesting cover on more than 25-50% of the units (acreage) in any given year.

Several hundred thousand acres of tall fescue on CRP land are being converted to cool-season grass/legume or native warm-season grass mixtures in Missouri (Clubine 1998). Moreover, fescue conversion techniques are steadily improving. Similarly, there appears to be hope for control of leafy spurge on prairies, at least on the Turner ranch in Montana, using "combinations of chemicals, conservative grazing [with bison], and fire" (Manning 1995:234)

Research Needs — "What's enough? . . . In other words, what's enough conservation?" is the "deceptively simple question" posed by Sawhill (1996:9). The question applies to minimum viable populations, the quantity of suitable grassland needed, and the level of management needed to support populations. These questions may override all others in importance in many areas of remaining prairie chicken range.

Translocations of greater prairie chickens have been working quite well over the last decade or so. However, if MVPs are not attained, how frequently must translocations occur to maintain numbers, genetic diversity, and population fitness? If "200 birds or 100 displaying cocks" and about 2,100 acres (850 ha) of suitable grasslands, or one third of a 6,300-acre (2,550 ha) open area are the critical minimums (Toepfer et al. 1990:575), we'd better know all that we can about what constitutes "suitable" grasslands for prairie chickens. How do such minimums vary throughout the bird's range? How do we allow for weather extremes, cyclic lows in numbers, excessive predation, interactions with pheasants, and a myriad other variables? What should be the relative proportions of nest cover and brooding habitats on management tracts for prairie chickens?

If "ecosystem management" is employed on lands originally acquired for prairie chickens, how will extensive tracts of undisturbed grassland for Henslow's sparrows (*Ammodramus henslowii*) affect nest success for the chickens? Recent research findings by McKee et al. (1998) indicate a negative impact. The list of questions is endless and the task of obtaining answers will increase in complexity as human pressures increase.

Research currently underway includes studies on habitat use, nesting, brood-rearing success, and dispersal. These are being conducted by the George M. Sutton Avian Research Center in Oklahoma (Horton and Wolfe 1999) and by John Toepfer (personal communication) of the Society of Tympanuchus Cupido Pinnatus,

Ltd. and his students in Wisconsin, Minnesota, and North Dakota. Similar studies are needed in Nebraska, particularly to forecast pre-hunt population levels (Vodehnal 1999). Better harvest data are needed in South Dakota (J. Heismeyer, personal communication) and probably in Kansas and Nebraska. In Missouri, field work was completed in 1997 on a study evaluating area-size effects on grassland birds (Winter 1998). In Minnesota, a feasibility study on reintroducing prairie chickens at Lac Qui Parle Wildlife Management Area, and other studies are underway. In Kansas, research is underway by the Department of Wildlife and Parks, and by Kansas State University, to evaluate effects of observer variability on booming ground counts. Additional efforts are being made to assess effects of route-specific land use changes on lek survey results. Models will be developed to correct future surveys for variables such as starting time and duration of count (Applegate and Horak 1999). Many research needs previously outlined by Robel (1980) remain unanswered and these answers should be sought.

Can there be too much research? This question was prompted by evidence that prairie chickens have been virtually evicted from the 8,616-acre (3,787-ha) Konza Prairie Research Natural Area in Kansas. According to R.J. Robel, in a personal communication, various counts of booming cocks and booming grounds showed respective "declines of 63% and 38% between 1980 and 1990 , even as research activity increased from 26–77 projects. Populations of lekking birds in the surrounding grasslands remained stable during the 10-year period," but currently, "there are virtually no prairie chickens on Konza Prairie." Prairie chickens can be remarkably tolerant of human intrusions, but these observations suggest tolerance limits have been exceeded at Konza. Can we expect better consideration for prairie chickens on the new Tallgrass Prairie National Preserve (10,800 acres [4,371 ha]) in Kansas, under the partnership of the National Park Service and the National Park Trust?

On The Nature Conservancy's Tallgrass Prairie Preserve (TGPP) in Oklahoma there are, or recently have been, 43 research projects. Counts of 58–126 male prairie chickens (R. Hamilton, personal communication) seem far too few for the entire preserve of 38,000 acres (15,378 ha). Will the "Konza scenario" be repeated at the TGPP? Who should be the judge of too much research?

Human intrusions should be minimal during 4 critical stages of the breeding season. These include: (1) the early morning and late afternoon periods during the peak of hen visitation on booming grounds, (2) the midday period when hens are laying eggs, (3) during incubation including morning and evening feeding periods (Westemeier et al. 1998c), and (4) the first 6 weeks of brooding (J. Toepfer, personal communication). These events typically include at least April, May, June, and the first half of July, throughout the range of the greater prairie chicken.

Public Needs — Perhaps the key question to ask the public is "Do you care if the prairie chicken is in trouble?" One cogent response came from an individual who subsequently became one of the best friends to Wisconsin prairie chickens: "Hell, I didn't even know he was in trouble" (Salsini 1991:17). Thus, a well-informed public is critical for public support. The bird will basically "sell itself" with its spectacular courtship ritual. Sitting in a blind on a booming ground in late March or April is one of the best ways to build public support for prairie chickens and associated grassland wildlife as well. To paraphrase Aldo Leopold, "relegating prairie chickens to Kansas is like relegating happiness to heaven; one may never get there. It is better to keep the prairie chicken that we have at home where they belong, now and tomorrow."

Public visitation can also garner valuable research partnerships (e.g., Hamerstrom and Hamerstrom 1973, Anderson and Toepfer 1999). However, such activities require careful supervision to avoid undue harassment during the critical breeding season. Supervision requires man-hours at a busy time of year for grassland managers. With careful attention to instruction on viewing etiquette, public viewing can often be accommodated from a roadside for those who do not wish to sit in a cold cramped blind for 2 or 3 hours (or

as long as it takes for all hens to leave on their own volition). Currently, about 900 persons view the courtship ritual of prairie chickens on Wisconsin's Buena Vista Marsh each April (Anderson and Toepfer 1999).

Summary of Conservation Needs — Booming ground surveys covering 5 decades in Wisconsin and 2.5 decades in Minnesota offer reassurance that a metapopulation interconnected with subpopulations totaling about 250–1,000 booming males in Wisconsin, and between 500–2,000 males in Minnesota, may be sufficient to stave off genetic depauperation. The declines of Attwater's prairie chicken in Texas (Morrow et al. 1996) and greater prairie chickens in Illinois also showed a need for metapopulations containing ≥250 males. Unlike theoretical models, these are "real world" indications of what minimum viable populations might be for greater prairie chickens.

The quantity of suitable grasslands needed to support an isolated minimum viable population of prairie chickens may range from 1,500 acres (607 ha) in Illinois to 13,000 acres (5,261 ha) or more in the northern and western range. Much depends on the quality and intensity of management once land control is gained, and on the density limits of chickens in different geographies and habitats. Securing habitat necessary to support minimum viable populations involves factors that vary widely across the greater prairie chicken range. States have varying degrees of support in terms of funding for land acquisition and land management. In the long run, funding, agency policy, and the ability to work with private landowners when public land acquisition is not possible, may mean as much to the stability of prairie chicken populations as habitat management.

As the climate changes, so also does management needs. In the higher-rainfall states, control of brush and exotic plants is a necessity. Farther west, grazing economics is the more crucial factor. Wherever prairie chicken survival is tied to private lands, it is also necessary to consider agriculture economics in conjunction with the development of management strategies that provide for both livestock and grassland wildlife. Various government and private cost sharing programs can be of great help. Research is needed on many fronts. Procuring a broad base of public support is fundamental to attracting monies, both private and public, for management and research purposes.

Recommendations

1. Among the 11 states with greater prairie chicken populations, we recommend vigorous programs that address both the needs of the birds and those of the public. Hunting at current regulatory levels appears warranted in 2 (Nebraska and South Dakota) of the 4 states that have enjoyed seasons in recent times. Some restrictions of hunting may be in order in Kansas. Season closure appears warranted in Oklahoma. Among the 7 states with no hunting seasons in recent times, Colorado, Iowa, Minnesota, North Dakota, and Wisconsin indicated that while preservation was their basic present concern, their hope was for limited hunting in the future. Missouri and Illinois are currently focusing only on preservation.

2. Annual booming ground surveys are a basic ongoing need in all states. Count procedures should follow the Hamerstrom method (1973), but we should remain open to refinements in survey methodology based on new research findings.

3. Strive for minimum viable populations with ≥100 males, but preferably >250 booming males that are sufficiently interconnected for regular demographic and genetic exchange. Isolation of small populations (<100 males) is probably occurring rangewide. There is wisdom in suggesting closure of hunting in range so affected.

4. Provide sufficient quantity and quality of grasslands suitable for successful nesting and brood rearing for at least minimum viable populations. Winter grains, particularly corn, are needed in close association with suitable roosting cover, especially in

the Great Plains and northern prairie chicken range. A grassland:cropland interspersion ratio of 75:25 on the landscape is generally ideal.

5. Maintain grasslands, particularly with the use of prescribed burning, light-to-moderate intensity rotational grazing, and/or high mowing on both public and private land. Frequency of rotations should not exceed every other year. Controlled burning every 3 or 4 years is generally accepted, except on sand or peat soils where burn frequency may be lengthened to 5 or 6 years.

6. We agree with the recommendation by Svedarsky and Van Amburg (1996:94) for the Sheyenne National Grasslands, in having at least "30% of the habitat around key booming grounds with spring residual vegetation measuring *100% visual obstruction (VOR) at 2.0 dm"* as a management goal. Further, "juxtaposition of habitat components is important in land management planning for prairie chicken. Nesting cover should be within 1–2 miles (1.6–3.2 km)of booming grounds and optimum brood cover should be adjacent to optimum nest cover. Winter food plots should be close to roosting cover. The overriding concern is to minimize movements and exposure to predators."

7. Restore highly fragmented grasslands by removing tree lines from fences and draws. This is essential to provide open, wide horizons and to minimize hunting perches for avian predators and denning sites for mammalian predators.

8. Promote incentive programs such as Partners for Prairie Wildlife (Missouri), state wetland and prairie tax credits, Prairie Bank, and Reinvest-in-Minnesota. Continue to promote wildlife incentives such as WHIP and EQUIP and improve wildlife benefits on Conservation Reserve Program grasslands with particular emphasis on grassland wildlife.

9. States like Illinois, or areas with small grassland tracts, may need intensive predator control during nesting seasons to keep apparent nest success above 50%. Similarly, control of pheasants (cocks and hens) may be necessary to minimize harassment of prairie chickens on booming grounds and parasitism of chicken nests.

10. Conduct research programs that do not jeopardize reproductive success of greater prairie chickens, especially during the peak hen visitation of booming season, mid-day egg laying, incubation (including twice-daily feeding flights), and brood rearing during the first 6 weeks of growth.

11. Create and maintain an informed public and encourage partnerships through a variety of programs, including supervised viewing of booming prairie chickens from blinds or from a safe distance without blinds.

12. Funding, staff, and equipment should be commensurate with the land available for management so as to maintain grasslands in attractive structures for the year-round needs of prairie chickens and other grassland wildlife.

13. Finally, communication channels need to be improved so that research findings can be quickly incorporated into management agendas. Because of the great time demand (several years or even decades) between data collection and publication in peer-reviewed journals, interim reporting (via newsletter, etc.) and meetings by groups such as the Prairie Grouse Technical Council should occur more frequently.

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