THE FEASIBILITY OF RE-ESTABLISHING GREATER PRAIRIE CHICKEN IN MANITOBA

by

Barbara R. Minish

A practicum submitted in partial
fulfillment of the requirements for the degree of
Master of Natural Resources Management

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ABSTRACT

The feasibility of re-establishing greater prairie chicken (Tympanuchus cupido pinnatus) in Manitoba was determined by means of a literature review, personal communications and field investigations.

The province contains areas that could provide suitable habitat for a transplanted population of greater prairie chicken. At present there are no sources of pen-reared birds for re-establishment. However, wild birds are likely available from Kansas, Nebraska, and Oklahoma. A three year re-establishment plan for Manitoba employs the methods which offer the greatest chance of success based on prior experience. Highlights of the plan include:

1. The use of wild birds as opposed to pen-reared birds for transplant,
2. transplant of males during the summer molt for years one and two of the plan with spring transplant of males and females in years two and three, and
3. holding sharp-tailed grouse (transported later to the state supplying greater prairie chicken) at the release site to reduce dispersal of transplanted greater prairie chicken.

Most prior attempts at re-establishing greater prairie chicken in other areas of North America have been unsuccessful. Although experience from other re-establishment projects is not directly applicable to the Manitoba situation, the experience is relevant. I recommend against the implementation of a program that has as its single objective the restoration of greater prairie chicken in Manitoba.

However, the re-establishment of greater prairie chicken might be viewed as part of a broader objective. A restoration program for the tallgrass prairie community would benefit a re-establishment project for greater prairie chicken, but would have as its ultimate goal the restoration of the ecosystem as a whole. I recommend the implementation of a grassland restoration program that has the re-establishment of greater prairie chicken as one of many objectives.

ACKNOWLEDGEMENTS

To misquote Will Rogers " I never met a greater prairie chicken I didn't like". Unfortunately, my experience with the bird is limited. In writing this document I have drawn on the expertise and tolerance of many dedicated and interested individuals whose knowledge of grouse greatly exceeds mine.

I would like to acknowledge my committee members, Bob Jones and Don Sexton. Their thoughts and comments provided direction throughout the research and writing of this practicum. Special thanks are due Rick Baydack, my faculty and academic advisor. Rick offered immeasurable support for my work tempered with well timed criticism. His enthusiasm for and belief in this project finally outlasted my doubt and frustration.

The Wildlife Branch of the Manitoba Department of Natural Resources provided financial support. Major financial support was also provided by "The Parental Bank of Swan River" - Mervyn and Dorothy Minish.

My sister Trish has given support above and beyond the call of sibling duty. She has spent countless late nights and early mornings typing, editing, teaching me to write, and generally nursing me through much of my academic career.

Finally, I dedicate this work to my parents Mervyn and Dorothy Minish. They instilled in me a love and respect for wildlife. Their unquestioning emotional and financial support made this practicum a reality.

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Chapter I

INTRODUCTION

1.1 PREAMBLE

The greater prairie chicken (*Tympanuchus cupido pinnatus*) is the grouse species most affected by human activities (Johnsgard 1973). Early agriculture allowed the greater prairie chicken to expand its original range (Thompson 1891 Hamerstrom 1939, Lumsden 1966, Christisen 1969, Westemeier 1971, Johnston and Smoliak 1976). Further development of agriculture caused the destruction and fragmentation of grassland and the associated decline in greater prairie chicken throughout their range (Hamerstrom and Hamerstrom 1961, Aldrich 1963, Christisen 1969).

The greater prairie chicken first arrived in Manitoba in 1881 and became a permanent resident of the Red River Valley by 1885 (Thompson 1891). The species increased rapidly until the early 1900's then declined (Johnston and Smoliak 1976). Although the Five-year report to the legislature on wildlife (MDNR 1983) listed the greater prairie chicken as endangered, the report also states that no confirmed sightings have been made since the 1950's.

1.2 PROBLEM STATEMENT

Greater prairie chicken are listed as an endangered species in Manitoba (MDNR 1983). In the same report, the development of a rare and endangered wildlife program was recognized as an important phase of future wildlife management in Manitoba. To help fulfill the second objective of the rare and endangered wildlife program (ie. to restore where feasible, populations of those species that are in jeopardy), the feasibility of re-establishing the greater prairie chicken in Manitoba should be determined. More recently, World Wildlife Fund's "Wild West" project has outlined "The Prairie Conservation Action Plan". The plan, which recognizes the greater prairie chicken as endangered, will focus on endangered species and habitat regions of the grassland and aspen parkland in the prairie provinces (WWF 1987). This study represents a necessary first step in determining whether the re-establishment of greater prairie chicken in Manitoba is biologically and economically feasible.

1.3 OBJECTIVES

The purpose of this study was to determine the feasibility of re-establishing greater prairie chicken in Manitoba.

Specific objectives were:

1. To determine habitat requirements of greater prairie chicken,
2. To assess whether Manitoba can provide habitat required for a re-established population of greater prairie chicken,
3. To evaluate the success of past attempts at re-establishing greater prairie chicken in other areas of North America,
4. To determine the sources and numbers of birds available for transplant,
5. If re-establishment is feasible, to develop a plan for Manitoba and,
6. To recommend whether or not a project to re-establish greater prairie chicken in Manitoba should be attempted.

1.4 METHODS

The objectives listed in the previous section were met utilizing three methods: 1) literature review, 2) field study, and 3) personal communications.

1.4.1 Literature Review

The principal method used in this study was a literature review. The literature was reviewed to determine:

1. Habitat requirements for greater prairie chicken,
2. Levels of success achieved in greater prairie chicken transplant projects undertaken in the past and the problems encountered, and
3. Methods of re-establishing greater prairie chicken which offer the greatest chance of success.

1.4.2 Field Study

Fourteen sites in southern Manitoba were selected for analysis of their potential as re-establishment sites (Figure 1). Selection of these sites was based on: information regarding the former range of greater prairie chicken in Manitoba; habitat requirements identified in the literature; and personal communications with R. K. Baydack (Univ. Man.), R. E. Jones (MDNR) and D. A. Sexton (Ducks Unlimited).

During summer 1983 and spring 1984, I assisted with a research project on sharp-tailed grouse on the Shilo Military Range (Baydack 1986). Additional data collected by Baydack for the years 1983-1985 provided information on vegetation types and population levels of sharp-tailed grouse in the area.

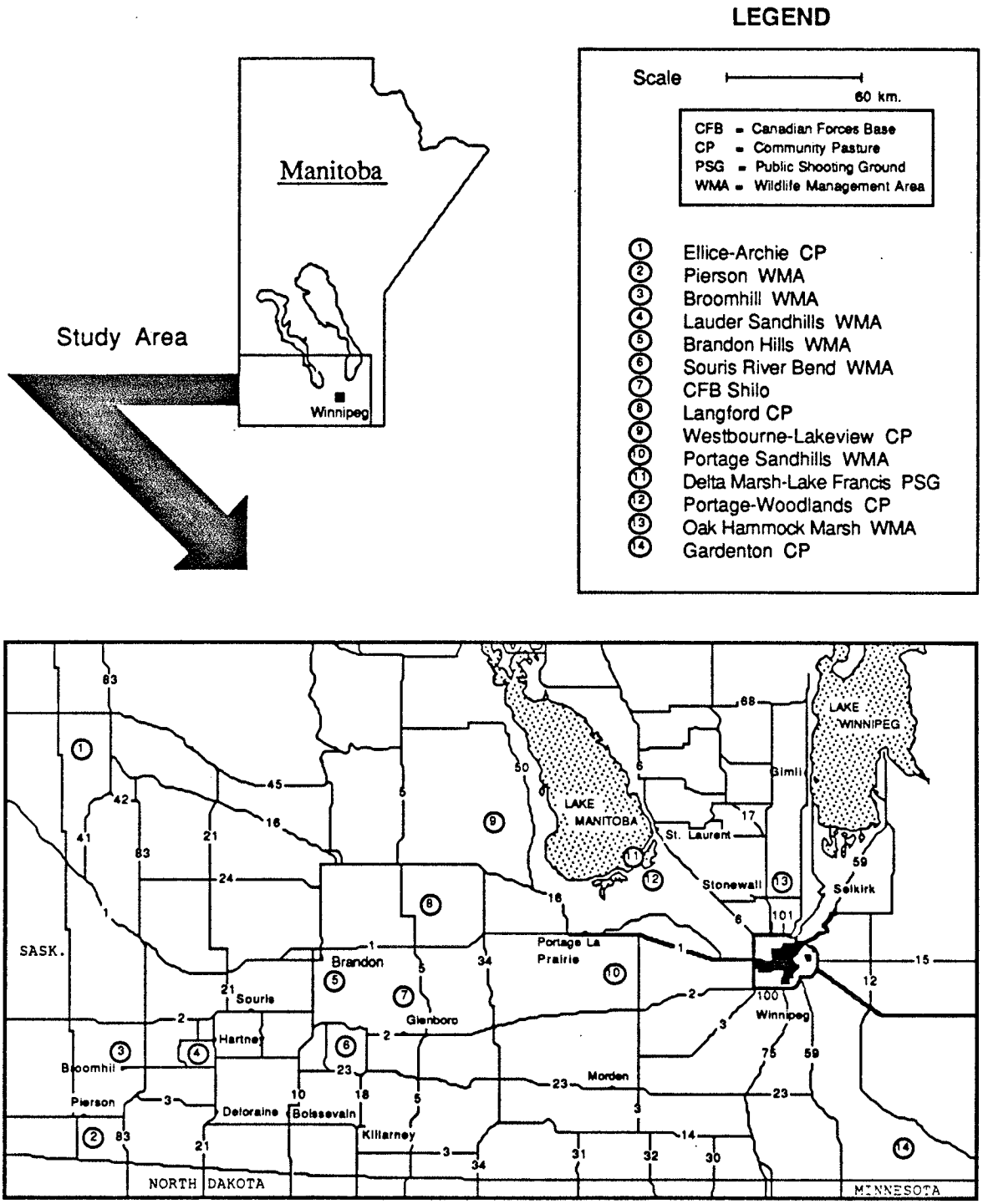

Figure 1: Location of potential re-establishment sites.

I visited Oak Hammock Marsh Wildlife Management area three mornings over a one week period in spring 1985 and obtained data for 1984 and 1986 from K. Whaley (MDNR) and B. Berger (Univ. Man.) to determine the number of sharp-tailed grouse in the area.

1.4.3 Personal Communications

I contacted wildlife authorities across Canada and the United States via letter and telephone to obtain information regarding habitat requirements for greater prairie chicken, and re-establishment attempts. As well, wildlife authorities in areas of stable greater prairie chicken populations were contacted to determine the availability of a supply of wild birds for transplant. I also visited the Northern Prairie Wildlife Research Center in Jamestown, North Dakota to observe the propagation facilities at the centre and determine the supply of propagated birds for transplant.

1.5 LIMITATIONS

1. A transplant of greater prairie chicken was not attempted in this study.
2. Cost estimates were for the transplant phase of the re-establishment plan and did not include costs of monitoring birds and habitat after the three year transplant is completed.

3. Pre and post release habitat management costs were not estimated.

Chapter II

LITERATURE REVIEW

2.1 HISTORY

2.1.1 Distribution

The greater prairie chicken is a bird of the climax grasslands, both the open shortgrass prairies and the mixed tallgrass and woodland of the oak-savannah area (Aldrich 1968). Originally, the species occurred in the climax grasslands of the eastern Great Plains from approximately the 100th meridian eastward to Kentucky, Ohio and Tennessee and northward to Michigan, Wisconsin, Minnesota and South Dakota (Sharpe 1968 *in* Johnsgard 1983). Within this original range only about ten states in the eastern or tallgrass prairie supported greater prairie chicken in sizeable populations (Christisen 1969).

Early agriculture allowed the greater prairie chicken to expand its original range (Thompson 1891, Hamerstrom 1939, Lumsden 1966, Christisen 1969, Westemeier 1971, Johnston and Smoliak 1976). Referring to the movement of greater prairie chicken into much of the Great Plains with the "homesteader and sodbuster", Christisen (1969) stated that the species was adaptable enough to persist in marginal habitat wherever

patches of farm food crops occurred in the extensive semi-arid grassland.

The greater prairie chicken followed agriculture northward from Minnesota and North Dakota into Manitoba by 1881 (Thompson 1891, Johnston and Smoliak 1976) and westward through Saskatchewan reaching Alberta by 1900 (Rowan 1926). Johnston and Smoliak suggested a combination of factors on the Canadian prairies which created the conditions in which greater prairie chicken populations increased rapidly. They proposed that with elimination of bison and subsequent increased hunting pressure on other ungulate populations, the prairie was virtually devoid of grazing animals by about 1880. In conjuction with the lack of grazing animals, higher than normal precipitation in the late 1870's and early 1880's allowed luxuriant growth of grass on the prairies. Agriculture spread west from Manitoba's Red River Settlement in the 1870's creating the scattered tracts of cultivation and ungrazed grasses that characterized the prairies from 1880 to about 1900 providing ideal habitat for the greater prairie chicken (Johnston and Smoliak 1976).

Aldrich (1963) and Johnsgard and Wood (1968) constructed range maps for the species. The maps differ from each other in their illustration of the original range of the bird. Figure 2 represents an amalgamation of the information offered by these authors regarding the original and acquired range of the greater prairie chicken.

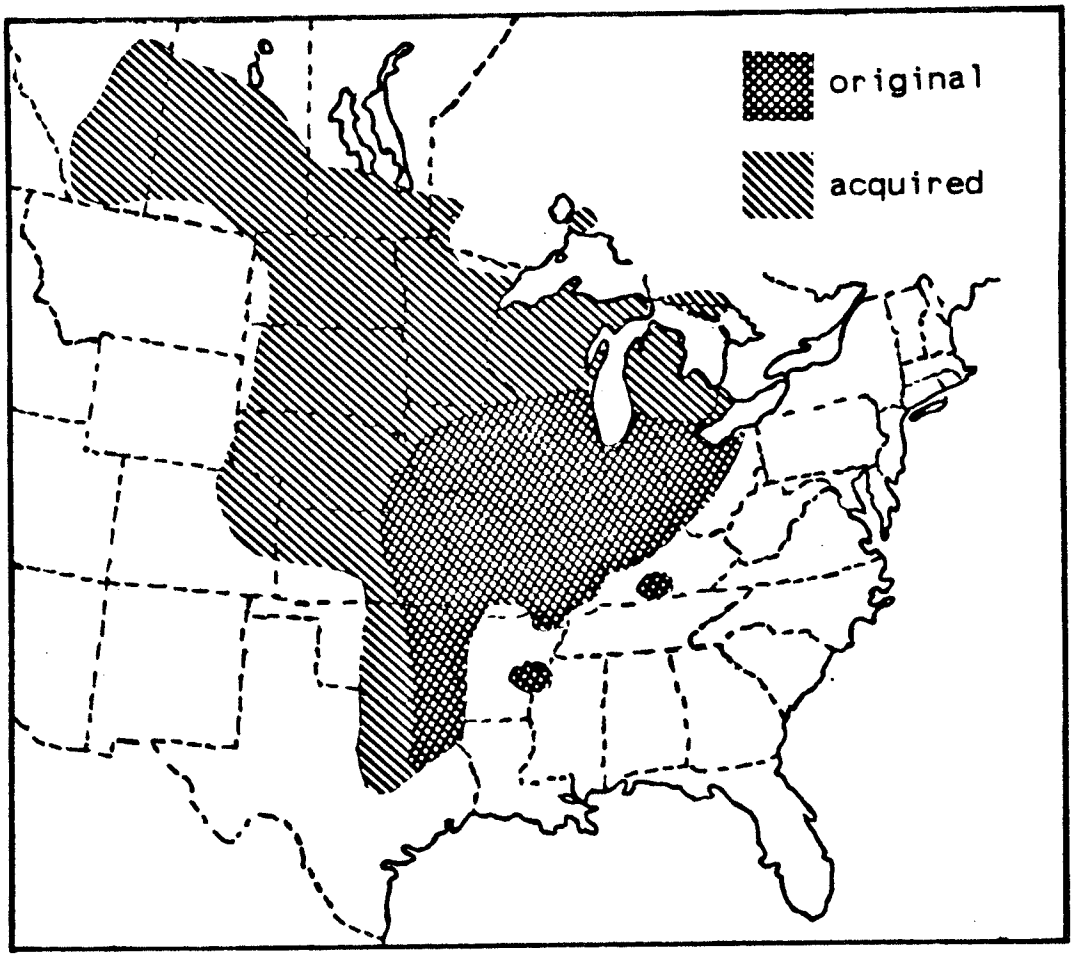

Figure 2: Original and acquired range of the greater prairie chicken in North America. (after Aldrich 1963 and Johnsgard and Wood 1968)

The entire geographic range of the greater prairie chicken has declined from its former extent. Figure 3 illustrates the most recent estimate of population and range.

2.1.2 Greater Prairie Chicken in Manitoba

Thompson (1891) offered the earliest record of the greater prairie chicken in Manitoba reporting that specimens had been taken near Winnipeg in 1881. By 1885 the greater prairie chicken was considered a permanent resident in the Red River Valley (Thompson 1891). The population of greater prairie chicken increased rapidly from 1881 to the early 1900's then declined (Johnston and Smoliak 1976).

COSEWIC (1985) listed the greater prairie chicken as endangered in Canada. However, in the 1979 status report (COSEWIC 1979) it was stated that some authorities believe the bird no longer breeds in Canada. The last confirmed sighting in Alberta was in spring of 1972 in the southwest of the province (Salt and Salt 1983). A single bird was sighted in south central Saskatchewan in 1972 (Brazier 1972a, 1972b). Hatch (1973) describes a greater prairie chicken shot by hunters in 1973 in southwestern Saskatchewan, and in 1976 a greater prairie chicken was seen foraging with a flock of sharp-tailed grouse (Tympanuchus phasianellus) near Biggar, Saskatchewan (Wapple 1977). The greater prairie chicken is now considered extirpated in both

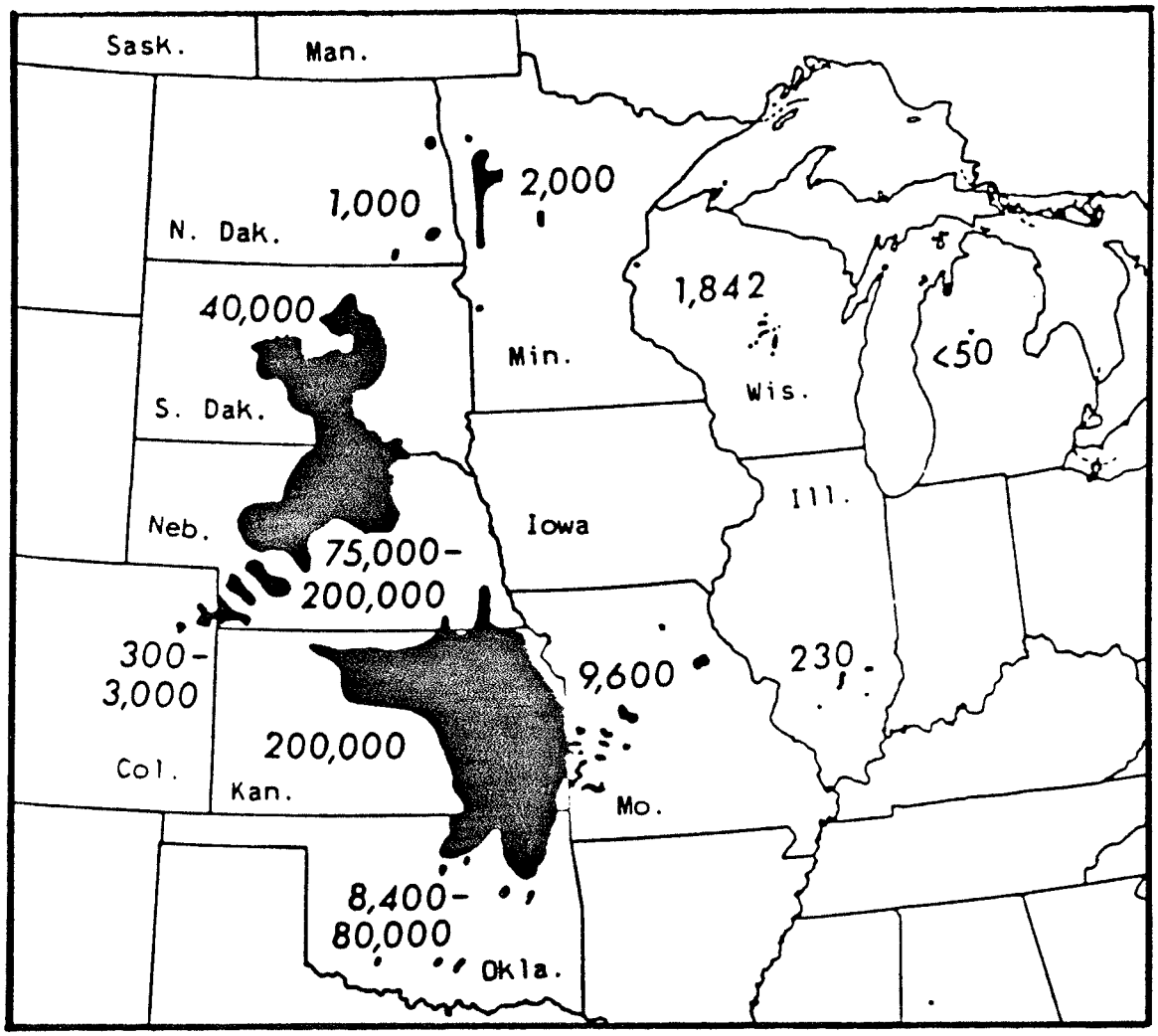

Figure 3: Range and estimated populations of greater prairie chicken in 1979 (Westemeier 1980).

Alberta (D. Moyles, pers. comm.) and Saskatchewan (A. Schmidt, pers. comm.).

Although the Five-year Report to the Legislature on Wildlife (MDNR 1983) listed the greater prairie chicken as endangered, the same document stated:

> . . . Since the disappearance in the early 1950's, of a group [of greater prairie chicken] which was located near the edge of Delta Marsh, there have been no confirmed sightings in the province.

From the mid 1970's through 1986 several unconfirmed sightings in southern Manitoba have been reported to MDNR.

There is discrepancy as to the extent of the greater prairie chicken's range in Manitoba. Godfrey (1966) claimed specimen records north to Peonan Point at the top of Lake Manitoba and sighting records to Grand Rapids. As well, a greater prairie chicken was taken in the Swan River area in 1938 (M.L. Minish, pers. comm.). These reports suggest scattered occurrences of the bird in Manitoba north of the boundaries offered by Aldrich (1963) and Johnsgard and Wood (1968).

2.1.3 Reasons for the Decline

The destruction of grassland habitat, which Hamerstrom et al. (1957) referred to as the "keystone in prairie chicken ecology", is repeatedly cited as the reason for the decline. The destruction and fragmentation of grassland through

cultivation and livestock grazing and the associated reduction of greater prairie chicken population has been recorded by: Yeatter (1963) and Vance (1976) for Illinois; Robertson (1980) for Nebraska; Kirsch et al. (1973) for North Dakota; Martin and Knopf (1980) for Oklahoma; Hamerstrom et al. (1957) and Westemeier (1971) for Wisconsin; Johnston and Smoliak (1976) for the Prairie Provinces; and Hamerstrom and Hamerstrom (1961), Aldrich (1963) and Christisen (1969) for the entire former range of the greater prairie chicken.

Johnston and Smoliak (1976), relating fluctuations in the number of greater prairie chicken to the settlement of the Prairie provinces, noted that it is ironic that the greater prairie chicken at first prospered from expanding agriculture which made available new resources and led to its establishment in vast regions of the Prairie provinces. This relationship is ironic in that it was the further development of cereal farming and cattle ranching that eliminated the tall grass vegetation on which the species depended (Johnston and Smoliak 1976).

2.2 ECOLOGY OF THE GREATER PRAIRIE CHICKEN

2.2.1 Introduction

Literature on the ecology of greater prairie chicken in Manitoba is limited. The biology and habitat requirements discussed in this section are based on information available

from several American states. Therefore, extrapolation and application of this information to Manitoba may be limited.

2.2.2 Reproductive Biology

The reproductive display of the greater prairie chicken occurs on a communal display ground or lek, referred to as a booming ground. Booming is the collective term given to the sequences of vocalizations and posturing of the male greater prairie chicken that serves both to announce territorial residence to other males and to attract females (Johnsgard 1973). For a detailed description of the display see Breckenridge (1929), Bent (1932) and Hjorth (1970).

Courtship occurs in the spring, however an active period of fall display is a regular phenomenon in greater prairie chicken (Johnsgard 1983). Female attendance during the fall display is less important than the re-establishment of territorial boundaries by mature and experienced males and the learning of display ground locations by young males (Johnsgard 1973).

Booming activity begins in the spring on the first warm days after the accumulated snow has melted from the display area (Bent 1932). Svedarsky (1979) stated that peak activity at the lek varies from year to year following the variation in the mean April temperature.

For Minnesota, Svedarsky (1979, 1983) observed a period of peak activity on the display ground from April 10-30. In his study, Svedarsky determined peak female attendance was on April 12 followed by a maximum number of copulations about April 20. Hamerstrom and Hamerstrom (1973) observed April 18 as the average for peak female attendance in Wisconsin with peak copulation between April 18-26. The Hamerstroms (1973) observed a second peak in attendance and copulation during the first 2 weeks of May suggesting renesting.

Egg laying begins approximately 4 days after copulation at a rate of one egg per day (Svedarsky 1983). Clutch size may vary from 7 to 17 (Bent 1932). Robel et al. (1970) found the number of eggs in the first clutch to vary from about 12 to 14. Svedarsky (1983) suggested a slightly higher average of 14.6 eggs for the first clutch. Concurring with Johnsgard (1973) who suggested that smaller clutch sizes represent renesting attempts, Robel (1970) and Svedarsky (1979) observed a decrease in clutch size in nests initiated later in the year.

Incubation begins as soon as the clutch is completed and continues for an average of 25.5 days (Svedarsky 1979).

Broods typically remain with females from six to eight weeks after hatching, when families gradually disperse (Johnsgard 1973). Bowman and Robel (1977) determined that

brood break up and dispersal occur in late August through September and suggest that brood break up may be triggered by seasonal factors rather than age of the young.

2.2.3 Habitat Requirements

2.2.3.1 Booming Grounds

Areas selected for booming grounds generally have low vegetation cover (Ammann 1957, Hamerstrom et al. 1957, Jones 1963, Anderson 1969, Evans and Gilbert 1969 and Westemeier 1971) and are usually located on ridges or other elevations (Ammann 1957, Jones 1963). Jones (1963) determined that the mean height of vegetation used for booming by greater prairie chicken was 15.1 cm. Anderson (1969) found that male greater prairie chicken did not appear to exhibit a preference for booming ground cover types. He observed that vegetation height rather than type of cover was selected, and that areas with short cover and wide viewing horizons were consistently preferred. Hamerstrom et al. (1957) also found that booming grounds were located on open exposed areas with wide viewing horizons and a variety of cover types including: short cover on grazed or mowed meadows; grass flattened under snow; and no cover at all as on plowed ground.

Lack of concealment on the booming ground seems to help the greater prairie chicken detect and avoid predators on the lek (Berger et al. 1963 and Hamerstrom et al. 1965). As Hamerstrom et al. (1957) stated:

> The possibility to see and be seen, to hear and be heard is plainly important to prairie chicken in the selection of booming grounds.

Bradbury and Gibson (1983) suggest that males may select areas of low vegetation to avoid competing with females for resources. If males select an area of sparse vegetation for booming they are not using nesting habitat. However, Bradbury and Gibson (1983) further state that lek site characteristics are so diverse that habitat selection by males is an unlikely determinant of lek location. They proposed two behavioural models of lek dispersion - male clumping at 'hotspots' through which the largest number of females are likely to pass; and females selecting mates at the largest aggregation of males over a given area. In both cases, however, Bradbury and Gibson (1983) cautioned that their models may be influenced by habitat suitability, predator defense, or other ecological determinants.

2.2.3.2 Nest Habitat

Hamerstrom et al. (1957) described nest-brood cover as grassland with a slight mixture of broad-leaved herbaceous plants and sedges. In selection for nest habitat the vegetative structure (height and density) is more significant than plant species composition (Hamerstrom et al. 1957, Tester and Marshall 1962, Jones 1963, Kirsch 1974, Svedarsky 1979, MDC 1984).

Svedarsky (1979) observed selection for nesting habitats with dense cover close to the ground (up to 20-30 cm). Buhnerkempe et al. (1984) suggested a preference for nesting cover densest between 26-36 cm above the ground. Jones (1963) and Drobney and Sparrowe (1977) found that vegetation averaged 45 cm around greater prairie chicken nests. Svedarsky determined a lower mean height of vegetation around greater prairie chicken nests (40 cm). Habitat with vegetation over 1 m is apparently not suitable for nesting (Svedarsky 1979, Buhnerkempe et al. 1984).

Kirsch et al. (1973), Brown (1978) and Buhnerkempe et al. (1984) noted the extreme importance of residual vegetation for nesting cover. The importance of this vegetation will be greatest during a given period of reduced summer precipitation as the birds become increasingly dependant on residual vegetation for cover (Brown 1978).

Hamerstrom (1939) proposed that nests tend to be localized around each booming ground. Robel (1970) stated that this tendency was not consistent. Robel (1970) and Svedarsky (1979) observed that females did not always nest closest to the booming ground on which they mated and suggested that females selected nest sites by characteristics other than proximity to a booming ground. Westemeier (1971) reported evidence of a preferred zone for nesting of 220 m from booming grounds surrounded by nesting cover. Drobney and Sparrowe (1977) also offered evidence

that where adequate cover is available, nests are localized around booming grounds but also stated, in agreement with Robel (1970) and Svedarsky (1979), that the quality of cover appears to be more important in nest site selection than proximity to a booming ground.

2.2.3.3 Brood Habitat

The term "nest-brood habitat" as used by Hamerstrom et al. (1957), Kirsch (1974), and Drobney and Sparrowe (1977) suggests that a given habitat is sufficient for both activities. Hamerstrom and Hamerstrom (1949) stated that broods probably stayed close to the vicinity of the nest for the first few weeks after hatching. However, Svedarsky (1979) indicated that preferred brooding areas were not the same as preferred nesting areas. He observed extensive movements by broods and suggested that these movements were "probably related to hens searching for satisfactory brooding areas, that is, the proper combination of insect quantities, ease of brood mobility and concealment cover". In agreement with Svedarsky (1979), MDC (1984) described brood habitat as sufficiently sparse to facilitate movement but dense enough to provide protection from summer heat and predators. Jones (1963) and Svedarsky (1979) noted differences between nesting and brood habitat, observing that brood habitat typically contained a greater number of forbs and also provided a larger number of insects which are important as food for growing young.

2.2.3.4 Escape Cover

Hamerstrom et al. (1957) stated that grassland is used as escape cover during warm months, although brush thickets are also used to some extent even by young broods. Jones (1963) determined that greater prairie chicken preferred tall coverts of either scattered or clumped vegetation for escape cover. He observed that the average height (about 60 cm) was considerably higher than that used for other activities. Drobney and Sparrowe's (1977) records of 383 observations of cover type used following flushing indicated that cover 20-90 cm in height was used for escape cover more than cover in the 10-19.9 cm category and that no birds used vegetation < 10 cm for escape. Drobney and Sparrowe (1977) also indicated the importance of dense annual weeds and shrubs as escape cover.

2.2.3.5 Roosting Habitat

According to Hamerstrom et al. (1957), grass is used for both day and night roosts from spring till early winter. Numerous tall stems, dense cover and dense understory (too thick for nest-brood cover) provide excellent roosting cover (Mohler 1952, Hamerstrom et al. 1957).

Deep snow is commonly used as roosting cover during winter (Bent 1932, Hamerstrom et al. 1957). Greater prairie chicken also use areas of tall dense vegetation,

brush patches and edges of woods for winter roosting (Mohler 1952, Hamerstrom et al. 1957).

2.2.3.6 Winter Habitat Requirements

Johnsgard (1973) stated that winter requirements for greater prairie chicken appear to centre on the availability of a stable source of winter foods rather than protective cover or shelter. MDC (1984) stated that prairie chickens quickly became dependent on waste grain for over-winter survival in areas north of their original range. The former range of greater prairie chicken in Manitoba is north of the original range of the species (Figure 2). Johnsgard's (1973) suggestion that availability of food is the central winter habitat requirement may therefore have particular application to Manitoba.

2.2.3.7 Summary of Habitat Requirements

Although not specific to Manitoba, the following habitat requirements have been documented across greater prairie chicken range in North America.

Greater prairie chicken require an elevated area with short vegetation cover and wide viewing horizons for booming (Ammann 1953, Hamerstrom et al. 1957, Jones 1963, Anderson 1969, Evans and Gilbert 1969, and Westeimeier 1971).

Nest habitat for greater prairie chicken is grassland with a mixture of broad-leaved herbaceous plants and sedges providing dense cover 20-40cm above the ground with an average vegetation height of 40-45cm (Hamerstrom et al. 1957, Tester and Marshall 1962, Jones 1963, Kirsch 1974, Drobney and Sparrowe 1977, Svedarsky 1979, Buhnerkempe et al. 1984).

Habitat similar to that described for nesting with a higher percentage of forbs and a greater number of insects is required for brood habitat (Jones 1963, Svedarsky 1979).

Escape cover is provided by grassland with vegetation of 20-90cm and by dense annual weeds and shrubs (Hamerstrom et al. 1957, Jones 1963, Drobney and Sparrowe 1977).

Greater prairie chicken utilize tall dense vegetation, brush patches, edges of woods and snow for roosting habitat (Bent 1932, Mohler 1952, Hamerstrom et al. 1957).

Table 1 gives a summary of requirements for greater prairie chicken.

2.2.4 Food Habits

Greater prairie chickens eat a variety of foods. Hamerstrom et al. (1957) stated that the list of foods include:"insects and greens in summer; fleshy fruits, weed seeds and small grains as soon as they ripen and for as long

TABLE 1

Summary of habitat requirements for greater prairie chicken.[1]

Activity	Habitat required
Booming	Open, elevated areas with short (15 cm) vegetation cover and wide viewing horizons.
Nesting	Grassland with slight mixture of broad-leaved herbaceous plants and sedges. Vegetation height 40-45 cm densest 20-40 cm above the ground.
Brooding	Similar to nesting habitat with higher % forbs and greater number of insects.
Escape	Grassland with vegetation height 20-90cm, dense annual weeds and shrubs.
Roosting	Tall dense vegetation, brush patches, edges of woods and snow in winter.

[1] Summarized from: Hamerstrom and Hamerstrom (1949), Mohler (1952), Ammann (1957), Hamerstrom et al. (1957), Jones (1963), Anderson (1969), Evans and Gilbert (1969), Westemeier (1971), Kirsch et al. (1973), Kirsch (1974), Drobney and Sparrowe (1979) and Buhnerkempe et al. (1984) and MDC (1984).

as they remain available; and with corn, buds, and catkins added in the autumn and winter".

Table 2 gives Toney's (1980) listing of principal foods of greater prairie chicken in Missouri. Several other investigators have also studied foods used by greater prairie chicken. Extensive food lists and the relative importance of each food can be found in: Schmidt (1936), Hamerstrom et al. (1941), Korschgen (1962) Jones (1963), Kobriger (1965), and Renhowe (1968). These reports do not differ greatly in the food items listed, however they showed variations in the importance of given food items.

Jones' (1963) data from two study areas which showed marked differences between the food use of greater prairie chicken. Jones (1963) stated that a determining factor of food use is the availability of preferred foods. The difference noted for the reports listed above may therefore reflect the relative abundance of food items rather than actual variations in food preference.

2.2.5 Range and Movements

Literature dealing with the range and movements of greater prairie chicken (Schmidt 1936, Hamerstrom and Hamerstrom 1949, Mohler 1952, Kobriger 1965, Robel et al. 1970, Drobney and Sparrowe 1977) suggested that different populations of greater prairie chicken have different

TABLE 2

Occurrence/volume percentages of the principal foods of greater prairie chicken in Taberville Prairie, Missouri, by season and year, 1978-79 (Toney 1980).

Food	Spring 300*	Summer 300*	Fall 300*	Winter 281*	Year 1,181*
Green leaf	46.0/16.7	68.7/43.2	33.0/24.8		37.5/21.5
Green grass	95.0/35.5	17.0/5.4	30.0/9.4	20.9/3.8	41.1/13.7
Wild rose	19.0/2.5	3.7/0.2	20.3/9.0	74.0/29.4	28.5/10.0
Wheat	23.7/8.9	0.3/0.3	18.7/9.9	38.0/19.7	19.9/9.5
Corn	16.7/9.0		8.7/5.3	43.4/22.6	16.8/9.0
Sorghum	15.3/7.3		29.7/14.5	20.6/9.6	16.3/7.8
Korean lespedeza	25.0/7.9	17.7/10.2	9.0/3.6	7.8/0.1	15.0/5.5
Soybeans	5.3/3.1	0.7/tr	4.0/3.8	6.0/4.7	4.0/2.9
Ladies' tobacco	15.7/3.0		5.3/1.6	15.6/3.6	9.1/2.0
Dwarf sumac		1.0/0.7	19.0/7.0	0.3/tr	5.0/2.0
Dewberry		17.0/7.0			4.3/1.8
Phlox		11.3/6.6			2.9/1.7
Buttonweed		10.7/5.0	7.7/0.6	0.3/tr	4.7/1.4
Red mulberry		13.7/5.6			3.5/1.4
Black cherry		9.3/4.4			2.4/1.1
Lanceleaf ragweed	2.0/tr	1.7/0.4	22.0/3.3	15.3/0.6	10.2/1.1
Early buttercup	14.0/3.1				3.6/0.8
Wild strawberry		10.7/2.8			2.7/0.7
Smooth sumac				15.3/2.2	3.6/0.5
Twigs and buds	9.3/0.4	1.7/0.1	1.7/0.1	15.3/1.3	6.9/0.4
Prairie dropseed			4.3/1.6		1.1/0.4
Gray dogwood		1.7/0.7	1.0/0.8		0.7/0.4
Swamp dogwood		1.3/0.6	1.3/0.8		0.7/0.4
Common ragweed			6.7/1.2	11.0/0.1	4.5/0.3
Mead's sedge	9.3/1.1				2.4/0.3
False dandelion		2.3/1.0			0.6/0.3
Spring beauty	23.0/0.8				5.8/0.2
Pencil flower		3.0/0.7			0.8/0.2
Slender lespedeza	0.3/tr		13.0/0.4	28.4/0.3	10.2/0.2
Sleepy catchfly	0.3/tr	18.7/0.6			4.8/0.2
Coralberry	0.3/tr		1.7/0.2	11.0/0.4	3.1/0.1
Horse nettle			3.7/0.5	1.0/tr	1.2/0.1
Tick-trefoils				4.6/0.5	1.1/0.1
Many-flowered rose	0.6/tr			1.0/0.4	0.4/0.1
Common lespedeza	3.0/tr		4.0/0.3	2.1/tr	2.3/0.1
Meadow fescue		0.7/tr		1.4/0.3	0.5/0.1
Sedge	4.3/0.3				1.1/0.1
Possum haw				1.7/0.2	0.3/0.1
Goat's rue		1.0/0.2			0.3/0.1
Crab-grass	2.0/tr	0.3/0.2	1.0/tr	0.3/tr	0.9/0.1
Insects	65.3/0.3	76.7/3.7	25.7/1.1	1.4/tr	43.4/1.3
Total	99.9	99.6	99.8	99.8	100.0

* Number of samples.

patterns of mobility. Comparing movements of birds in three areas of Wisconsin, Hamerstrom and Hamerstrom (1949) found that the longest movement for one population was 7.5 miles (12 km) and compared to 29 miles (47 km) and 100 miles (161 km) among two other populations.

Robel et al. (1970) and Drobney and Sparrowe (1977) observed that the longest daily movements of male greater prairie chicken occurred in February. Robel et al. (1970) suggested that the peak daily movements are a result of intensified food seeking coupled with almost daily sexual displays on the booming grounds. Daily movements for males decrease in distance begining in March reaching a minimum in August (Robel et al. 1970). Greatest daily movements for females occur in April and smallest movements in September (Robel et al. 1970). Robel et al. (1977) suggested that in the winter most daily movements are associated with food seeking and that summer is the period of least extensive movement when food is readily available and easily accessible.

Mohler (1952) stated that home ranges for greater prairie chicken are approximately 2,000 a (810 ha). However, data from Robel et al. (1970) suggest a smaller home range. They observed that 1,267 a (513 ha) was the largest range for greater prairie chicken. With respect to variations in range and movement patterns of greater prairie chicken, Hamerstrom and Hamerstrom (1949) suggested that greater

prairie chicken can and will make wide local movements, even migrations, if necessary, but that the usual condition for greater prairie chicken is to spend their lives in a small area.

2.2.6 Interspecific Interactions

2.2.6.1 Other Upland Gamebirds

Sharp (1957) studied interactions between greater prairie chicken, sharp-tailed grouse and pheasants (Phasianus colchicus) on booming grounds. He observed that greater prairie chicken were unable to cope successfully with either sharp-tailed grouse or pheasants. On small leks with few displaying males, pheasants can easily disrupt the booming ground to the extent that breeding could be delayed or prevented (Harger 1956, Vance and Westemeier 1979).

Pheasants also limit the reproductive success of greater prairie chicken by nest parasitism (Vance and Westemeier 1979 and Westemeier 1980).

Sparling (1979) determined that differences in habitat preferences of greater prairie chicken and sharp-tailed grouse in his study area were slight or non-existent. He suggested that the similarities may have been due to the wider habitat tolerances of sharp-tailed grouse overlapping the more restricted preferences of greater prairie chicken. Preliminary investigations suggested that there is

competition in spring between female greater prairie chicken and sharp-tailed grouse for nest sites and that sharp-tailed grouse dominate (J. Toepfer, pers. comm.).

Another aspect of greater prairie chicken and sharp-tailed grouse interaction is hybridization. Hybridization between these species has been documented by Rowan (1926), Lumsden (1965), Short (1967), McEwen et al. (1969), Lumsden (1970), Hamerstrom and Hamerstrom (1973), Sparling (1979, 1980), Svedarsky and Kalahar (1980) and Johnsgard (1983).

Sparling (1979) found no consistent difference between greater prairie chicken and sharp-tailed grouse in the type of area chosen for display grounds. Although other researchers (e.g. Ammann 1957, Johnsgard 1973) indicated that sharp-tailed grouse tolerate higher vegetation on the lek, the differences were small. Mixed display grounds have been observed by Lumsden (1965), Johnsgard and Wood (1968), Lumsden (1970), Hamerstrom and Hamerstrom (1973), and Sparling (1979, 1980). Johnsgard and Wood (1968) stated that the percent of mixed display grounds ranged from 17-18% in mid-western states, and suggested a 0.3%-1.2% rate of hybridization in Nebraska. One third of the display grounds in Sparling's (1980) Minnesota study were mixed. He stated that hybridization appears to occur in all sympatric areas at rates from <1-3% of parental species population.

Sparling (1980) suggested that because greater prairie chicken populations are discontinuous in areas of sympatry, effective isolating mechanisms may not have evolved. Therefore, greater prairie chicken may be more subject to adverse effects of interspecific competition and hybridization than if they were continuous. As well, detrimental interactions "may be most intense when the 2 species occupy roughly equivalent ecological niches in habitat that is marginal for 1 or both species" (Vance and Westemeier 1979). H. G. Lumsden (pers. comm.) supports Sparling's theory and suggested that the high rate of hybridization (up to 70% of parental populations) on Manitoulin Island in Lake Huron is due to this area being the only point of sympatry for greater prairie chicken and the northern subspecies of sharp-tailed grouse (*T. p. phasianellus*).

Johnsgard and Wood (1968) suggested that intermating would be most likely with females of the least common species. Concurring with these authors, Sparling (1979) stated that hybridization is most likely to occur when a female has a difficult time finding a conspecific. Sparling further suggested that the rate of hybridization will increase as population sizes of the parental species diverge.

McEwen *et al.* (1969) and Sparling (1979) proved that greater prairie chicken X sharp-tailed grouse hybrids are

fertile. Sparling (1979) also determined that backcrossing can occur. Following Johnsgard and Wood (1968) and Sparling's (1979) assertion that intermating will be most likely with females of the least abundant species, backcrosses should be most common between hybrid females and males of the more common parental species. This will result in a decline in the numbers of genetically pure animals in the least abundant species.

2.2.6.2 Predation

Berger et al. (1963) observed a total of 1,379 encounters between raptors and greater prairie chicken. Greater prairie chicken reactions to raptors were varying amounts of flushing and squatting. During the study, only three known kills were made: one each by a snowy owl (Nyctea scandiaca), a great horned owl (Bubo viginianus) and a harrier (Circus cyaneus). Another raptor known to have killed greater prairie chicken on booming grounds is the goshawk (Accipiter gentilis) (Moran 1966).

Hamerstrom et al. (1965) studied the effects of mammals on greater prairie chicken leks. In 4,745 blind-mornings 179 incidents involving mammals were observed. Of these encounters only one kill (by a domestic dog) was observed. Red fox (Vulpes fulva), badger (Taxidea taxus), striped skunk (Mephitis mephitis), coyote (Canis latrans) and domestic cat elicited some degree of response (crouching or

increased alertness) when on or near booming grounds but were easily evaded (Hamerstrom et al. 1965).

Greater prairie chicken frequently select open, exposed areas for booming grounds and appear vulnerable to predation. However, Berger et al. (1963) concluded that few predators are capable of catching a healthy greater prairie chicken by surprise and that lack of concealment on the booming ground works in the greater prairie chicken's favour.

Predation of nests appears to be more limiting to greater prairie chicken populations than predation on adults. Robel (1970) listed striped skunks, coyotes and raccoons (Procyon lotor) as nest predators. Westemeier (1980) suggested that nest predation by skunks was a factor in the decline of greater prairie chicken in Illinois.

2.3 MANAGEMENT

Hamerstrom and Hamerstrom (1961) state that the management of greater prairie chicken is primarily land management. Westemeier (1980) states that "almost without exception the limiting factor for greater prairie chickens continues to be a lack of suitable grassland - principally for nesting, but also for brooding and roosting". Recommended management practices for greater prairie chicken will therefore centre on provision of grassland of sufficient quality and quantity.

To establish grassland habitat for greater prairie chicken, Yeatter (1963), Sanderson and Edwards (1966), Kirsch (1974), Christisen (1978) and George et al. (1979) suggest seeding native grasses. Recommended grasses are: little bluestem (Andropogon scoparius), big bluestem (Andropogon gerardi), Indian grass (Sorghastrum nutans), and switch grass (Panicum virgatum) (Christisen 1978, George et al. 1979). Christisen (1978) stated that the structural strength and clump effect of these grasses give optimum shelter for nesting, brood rearing and roosting without impairing movement at the ground.

For nest habitat, Buhnerkempe et al. (1984) suggested that habitat should be managed so that 90% of standing vegetation is distributed below 40 cm and the vertical aspect of the vegetation dense up to that point. Kirsch (1974) suggests that the most successful method for maintaining this habitat is prescribed burning. Prescribed burning is also recommended by Tester and Marshall (1962), Bowman and Robel (1977), Kirsch et al. (1978), and Westemeier (1980). Control burns stimulate growth of warm season grasses, increase seed germination and growth of broadleaf plants, and retard non-native plant species (MCC 1980). Optimum burning dates vary with geographic range but as a general rule MCC (1980) recommends burning when the bluestems' spring growth reach approximately 1 inch (2.5 cm).

Required frequency of burns varies over the geographic range and with differences in the successional stage of the vegetation (Kirsch 1974). Kirsch (1974) recommends burning at 3-5 year intervals for much of the greater prairie chicken's range. Tester and Marshall (1962) suggest burning 1/4 of a management area on an annual basis resulting in a four year rotational management scheme. The rotational approach allows for the development of residual vegetation on 3/4 of the managed area. As noted in section 2.2.3, residual vegetation is important for nesting cover.

For a more detailed description of grassland restoration techniques see Carson (1986).

Hamerstrom and Hamerstrom (1961), Yeatter (1963), Evans (1968) and Westemeier (1980) suggested that properly managed livestock grazing under a "take half, leave half" (rest rotational) regime is beneficial to greater prairie chicken. However, Kirsch et al. (1973), Kirsch (1974), Brown (1978) and Kirsch et al. (1978) found that the removal of residual vegetation by annual grazing is detrimental to greater prairie chicken populations. Livestock grazing removes herbaceous vegetation and deprives grassland birds of their principal cover - residual grasses (Brown 1978).

From his experience in North Dakota, Kirsch (1974) questioned the need for winter feeding and did not recommend it as a management practice. Kirsch (1974) contended that

habitat properly managed to provide nest-brood and roosting cover provides adequate winter food. Other authors suggested a need for providing winter feeding stations in areas of heavy winter snow. (Hamerstrom et al. 1941, Hamerstrom et al. 1957, Kobriger 1965, Bowman and Robel 1977, Westemeier 1980).

Chapter III

RE-ESTABLISHMENT EXPERIENCE

3.1 INTRODUCTION

Kruse (1973) summarized attempts to re-establish greater prairie chicken for the years prior to 1973. Although early reports of restoration attempts were positive, in general transplant attempts achieved only limited, short-term success.

Re-establishment projects entailed:

1. The propagation and release of pen-reared birds,
2. The capture and transplant of wild birds, or
3. A combination of the above methods.

3.2 RE-ESTABLISHMENT USING PEN-REARED BIRDS

Re-establishing greater prairie chicken by releasing pen-reared birds has been attempted in Illinois, Manitoba and Wisconsin.

In 1964, 41 pen-reared birds were released on the Cook County Forest Preserve, Illinois (Shoemaker 1964, 1965). No booming ground was established and the release was considered unsuccessful (Kruse 1973).

During the 1970's in Manitoba, Transcona Fish and Game Club purchased 25 chicks from the Northern Prairie Wildlife Research Centre at Jamestown, North Dakota. Ten of the 25 birds died within the first 4-5 months. Only six birds survived to be released (T. Thompson pers. comm.). Details of the release location and timing were unavailable. There have been no confirmed sightings of greater prairie chickens since the release (MDNR 1983).

Between 1974 and 1976, 225 pen-reared birds were released on Crex Meadows Wildlife Area in northwestern Wisconsin (Toepfer 1975, 1976, 1978, 1983). The flushing and flight distances of pen-reared birds was 40% less than those of wild birds (Toepfer 1983). The annual survival rate of pen-reared birds was 0% in 1975 and 0.7% in 1976 (Toepfer 1983).

Only one pen-reared hen was observed with a brood. This brood was eventually lost and no pen-reared hens were believed to have fledged chicks (Toepfer 1983).

3.3 RE-ESTABLISHMENT USING TRANSPLANTED WILD BIRDS

Restocking attempts using transplanted wild birds were made in: Colorado, 1984; Illinois, 1955, 1956; Iowa, 1980, 1982; Missouri, 1961, 1965, 1966, 1971, 1973; Oklahoma, 1956-1959, 1962-1973; South Dakota, 1959, 1960; Wisconsin 1976, 1977; and Wyoming, 1960. The attempts in Colorado

(Miller 1984), Illinois (Miller 1960), Iowa (Nuttall 1984), Missouri (Kruse 1973) and Wyoming (Wrakestraw 1960 in Kruse 1973) were on a small scale with releases of between 5 and 36 birds. Only the Colorado attempt gave encouraging results and the project is too recent to judge its long term success. In South Dakota 72 birds were released during two consecutive springs. Seventeen birds were released in 1959 and 55 in 1960 (Miller 1960). No booming grounds were established and the attempt was considered unsuccessful (Miller 1960). Oklahoma has conducted the largest scale transplant. From 1956 to 1959, 370 birds were released on four restoration sites (Jacobs 1959). Early reports from this restocking attempt were positive (Hamerstrom and Hamerstrom 1961, Miller 1960). Booming grounds were established and reproduction was noted on three areas in the first years following the release (Jacobs 1959). However, by 1964 populations on all restoration areas dropped between 23-75% (Mace 1964), and by 1972 restored populations were essentially gone (Kruse 1973). From 1962 to 1973, 704 birds were released in three areas of Oklahoma. In this attempt, habitat of the release site was closely matched to habitat from which the birds were taken. As of 1973, booming grounds were located in all release areas (Kruse 1973).

Toepfer (1975, 1976, 1978, 1983), offers a well documented account of his re-establishment project. In the Crex Meadows project both pen-reared birds and transplant

wild birds were used. From April 1976 to August 1977, 60 wild birds were transplanted in two spring releases, one summer release and one late summer release.

Wild birds were captured on booming grounds during spring using rocketnets and bownets. Birds for spring release were transported and released. Birds for summer and late summer release were radio-tagged and released in place. These birds were recaptured by nightlighting in June and August (Toepfer 1976, 1978, 1983).

Wild cocks released in April of 1976 were attracted to the hens and displaying cocks (pen-reared) in holding pens near the release site (Toepfer 1983). Six of seven radio-tagged cocks and nine of 12 nonradio-tagged cocks established territories or were observed displaying within a mile of the release site during April and May (Toepfer 1983). Wild hens did not show the same attraction to the penned birds as most made extensive wandering movements away from the release site making daily moves that at times exceeded 10 miles (16 km) (Toepfer 1983).

Seventy nine percent of cocks and 42% of hens transplanted in April 1976 remained in the area. The respective settlement of the 1977 April and summer transplants was 32% and 80%. Annual survival of the 1976 released birds was 23%. Annual survival of the 1977 April and summer released birds was 26% and 40% respectively (Toepfer 1983).

Although spring censusing showed an increase from 15 greater prairie in 1976 to 21 in 1979 (Toepfer 1983), a 1983 census of the Crex Meadows area indicated 10 greater prairie chicken cocks (Toepfer pers. comm.).

3.4 SUMMARY

Documentation of failed transplant attempts and reasons for failure is poor. However, lack of success in transplant attempts can be attributed to two major factors: excessive predation and dispersal from release site. The problem of predation is most acute when pen-reared birds are used. Dispersal of birds from re-establishment area is a problem when wild birds are used.

As reported earlier, pen-reared birds are more susceptible to predation than wild birds. Toepfer (1983) recommended that if pen-reared birds are used, an effort should be made to improve the wariness of the birds and a predator suppression program be conducted two months before and after the release.

Dispersal of wild birds was reduced in Oklahoma when the habitat the birds were released into matched that from which they were taken (Kruse 1973). In the Crex Meadows project, some birds were released during the summer molt when mobility is low in order to reduce post-release movements (Toepfer 1983). Dispersal of cocks from release site was

reduced by the presence of penned birds at the release site (Toepfer 1983).

Chapter IV

RE-ESTABLISHMENT PLAN FOR MANITOBA

4.1 INTRODUCTION

The re-establishment plan proposed in this document is a hybrid of several past attempts at re-establishment and management strategies. The success or failure of past attempts at re-establishment, though relevant, is not directly applicable to a transplant attempt in Manitoba. The plan outlined employs the methods which offer the greatest chance of success based on a review of methods and results of past re-establishment attempts.

4.2 SELECTION OF RE-ESTABLISHMENT SITE

4.2.1 Site Requirements

4.2.1.1 Grassland

The literature does not offer a consensus as to the minimum amount of grassland habitat required to maintain a population of greater prairie chicken. From their work in Wisconsin, Hamerstrom et al. (1957) state that 4660 ha (one half township) is the minimum area capable of supporting a self contained population of greater prairie chicken and suggested 1036 ha (four square miles) as the

minimum area to consider as a management unit with no more than 20-25% wooded. Reports of greater prairie chicken in North Dakota living on as little as 65 ha (160 a) (Kirsch 1974) suggests that the absolute minimum area required to sustain a population of greater prairie chicken varies. The higher the quality of the habitat, - that is, the more it conforms to the requirements listed in Table 1 - the less area will be required. Kirsch (1974) recommends that management units contain at least 518 ha (two square miles) of high quality habitat in blocks of not less than 65 ha (160 a) with a minimum width of 0.8 km (one-half mile). Based on his 5 year study in Wisconsin, Toepfer (1983) recommends a 4 X 4 km (2.5 X 2.5 mile) treeless area with 405 ha (1,000 a) or more of undisturbed grass in nothing less than 60 ha (150 a) blocks for a release site.

Based on Hamerstrom et al. (1957) and Toepfer (1983), I suggest for a release site in Manitoba, a 4 X 4 km area no more than 10% wooded with 405 ha or more of non-agricultural grassland in blocks of no less than 60 ha.

As suggested earlier, the quality of the habitat in a specific area will dictate the absolute minimum area required to support a population of greater prairie chicken. Since nest-brood habitat is the most critical factor limiting greater prairie chicken (Kirsch 1974, Westemeier 1980), the quality of nest-brood habitat in the release area is an important criterion. Vegetation height of grassland

in the re-establishment area should be 40 - 45 cm and dense in the spring (Drobney and Sparrowe 1977, Svedarsky 1979).

The following warm season grasses have the structural strength and clump effect which provide optimum shelter for nesting, brood rearing and roosting: little bluestem, big bluestem, Indian grass, and switch grass (Christisen 1978). These grasses should be present on the release site.

4.2.1.2 Absence of Sharp-tailed Grouse

As discussed in section 2.2.5, sharp-tailed grouse interact with greater prairie chicken. A primary concern regarding sharp-tailed grouse is the probability of hybridization. Sparling (1979) suggested that the rate of hybridization will be greater if one parental population is higher than the other. This would be the situation if a relatively small population of transplanted greater prairie chicken were released in an area already populated by sharp-tailed grouse. Through hybridization, the sharp-tailed grouse may genetically swamp the re-established population of greater prairie chicken. A second concern regarding sharp-tailed grouse is competition between sharp-tailed grouse hens and greater prairie chicken hens for nesting cover (J. Toepfer, pers. comm.).

For reasons listed above, sharp-tailed grouse are undesireable on a release site. However, due to overlapping

of their habitat preferences, an area suitable for greater prairie chicken and free of sharp-tailed grouse is probably not available in Manitoba. For a release site to be suitable, sharp-tailed grouse in the area must be accessible for trapping and removal.

4.2.1.3 Food Sources

Toepfer (1983) recommends that a release area have agriculture in the form of documented seasonal prairie chicken foods, and in regions with heavy snow, food patches. Kirsch (1974) suggested that grassland properly managed for nesting habitat will provide sufficient summer and winter food for a population of greater prairie chicken. However, Manitoba does not offer extensive grasslands, therefore the release site must be able to be managed to provide supplemental winter food sources.

4.2.1.4 Past History of Greater Prairie Chicken

Toepfer (1983) recommended the past occurrence of greater prairie chicken in an area as one criteria for assessing the suitability of the area for a transplant site. In the case of Manitoba, a viable population of greater prairie chicken has been absent for at least 30 years. Habitat changes due to changing land management practices will have altered much of the area once inhabited by greater prairie chicken. Therefore, although the past occurrence of the bird in an

area is a positive indicator, the present suitability of habitat in a potential release site is more important.

4.2.1.5 Departmental Control of Activities

Because the release site should provide non-agricultural grassland and because the released greater prairie chicken must be protected from hunting, the release site should be under the control of the Department of Natural Resources (DNR). DNR control may be direct as in the case of a Wildlife Management Area or indirect through agreement with the responsible government department or private landowner.

4.2.1.6 Summary of Site Requirements

The suitability of an area for a release site should be assessed using the following criteria:

1. 4 X 4 km area no more than 10% wooded.
2. 405 ha or more of uncultivated grassland in blocks no less than 60 ha.
3. The occurrence of the following grasses: little blue stem, big bluestem, Indian grass, and switch grass.
4. Ease of removal of sharp-tailed grouse.
5. Agriculture in the form of documented seasonal prairie chicken foods.
6. Area can be managed to provide supplemental winter food sources.

7. Past occurrence of greater prairie chicken.
8. Departmental control of activities.

4.2.2 Evaluation of Potential Release Sites

Potential release sites (Figure 1) were evaluated using the criteria listed above. Each criterion listed in section 4.2.1.6 has been assigned a number between 1 and 12. This number corresponds to the relative importance of that criterion in determining the suitability of an area as a release site. The relative importance of each criterion was assigned based on habitat requirements and transplant requirements discussed in previous sections.

For each criterion the individual sites have scored either the entire point value, or no points, or somewhere in between depending on the degree to which the site fulfills that criterion. This analysis has resulted in a ratio of points scored over total points possible for each site. If no information was available on a given criterion, no points were scored and the point value of that criterion was removed from the denominator of the final ratio. Each ratio was then converted into a percentage in order to produce a numerical value describing the suitability of each site according to the criteria listed (Table 3).

The numerical value assigned to a site for a given criterion was based on my interpretation of the information

TABLE 3

Evaluation of selected areas as release sites (as of 1987).

criteria	point value of criterion	potential release sites: Ellice-Archie CP	Pierson WMA	Broomhill WMA	Lauder Sandhills WMA	Brandon Hills WMA	Souris River Bend WMA	CFB Shilo	Langford CP	Westbourne-Lakeview CP	Portage Sandhills WMA	Delta Marsh-Lake Francis PSG	Portage-Woodlands CP	Oak Hammock Marsh WMA	Gardenton CP
4 X 4 km area <10% wooded	12	12[1,2]	3[4]	2[6]	6[7]	1[5,6]	4[5,9]	12[10]	7[1]	12[1]	6[11]	12[11]	12[1]	12[17]	10[1]
405 h non-agricultural grassland, >60 h blocks	12	0[1,2]	8[4]	8[6]	12[7]	2[6]	6[5,9]	12[10]	0[1]	0[1]	12[11]	10[11]	0[1]	12[17]	0[1]
big bluestem, little bluestem, Indian grass and switchgrass	8		4[5]	4[5,6]	0[5,7]	0[5]	4[5,9]	6[11]			4[11]	5[14,15]		6[15]	
ease of removing sharp-tailed grouse	12	6[2]	4[5]	4[5]	6[5]	10[5]	6[5]	2[12]			2[11]	6[11]	6[11]	8[16,19]	
cereal farming in the surrounding area	8	6[2]	8[5]	8[5]	8[5]	8[5]	8[5]	6[12]	4	4	6[11]	6	6	8[17]	6
ease of supplemental feeding	8	6	8	8	8	8	8	6[12]	4	4	6[11]	6	4	8	4
past occurrence of greater prairie chicken	4	3[3]	3[3]	4[3,5]	3[3]	3[3]	3[3]	4[3,13]	3[3]	3[3]	3[3]	4[3,18]	3[3]	3[3]	3[3]
Departmental control of area	6	4	6	6	6	6	6	4	4	4	4	4	4	6	4
total/possible	70/70	37/62	44/70	44/70	49/70	38/70	45/70	52/70	22/50	27/50	43/70	53/70	29/50	63/70	27/50
% score	100	60	63	63	70	54	64	74	44	54	61	76	58	90	54

Table 3 con't (footnotes).

[1] PFRA.1987. Memo to CWS. re: Community pasture vegetation inventory evaluation.

[2] Patimore, J. H. 1985. The feasibility of reintroducing the swift fox to southwestern Manitoba. Master Nat. Resour. Manage. Practicum. Univ. Manitoba, Winnipeg. 102pp.

[3] Figure 2: Original and acquired range of the greater prairie chicken (after Aldrich 1963 and Johnsgard and Wood 1968).

[4] McPhail, K. E. 1978. A management plan for the Pierson wildlife area. Man. Dep. Nat. Resour. Wildl. Rep. 78-38, Brandon. 13pp.

[5] Bidlake, L.J. personal communication.

[6] _____. 1978a. A management plan for the Broomhill wildlife area. Man. Dep. Nat. Resour. Wildl. Rep. 78-31, Brandon. 21pp.

[7] _____. 1978b. A management plan for the Lauder Sandhills wildlife area. Man. Dep. Nat. Resour. Wildl. Rep. 78-37, Brandon. 35pp.

[8] Bidlake, L. J. 1978c. A management plan for the Brandon Hills wildlife area. Man. Dep. Nat. Resour. Wildl. Rep. 78-30, Brandon. 17pp.

[9] _____. 1978d. A management plan for the Souris River Bend wildlife area. Man. Dep. Nat. Resour. Wildl. Rep. 78-32, Brandon. 33pp.

[10] Dixon, R. 1979. A remote sensing classification of vegetation for selected areas of C.F.B. Shilo. Man. Dep. Mines, Nat. Resour., and Environ. Tech. Rep. 79-4, Winnipeg. 39pp.

[11] Jones, R. E. personal communication.

[12] Baydack, R. K. personal communication.

[13] Leavesly, K. personal communiction.

[14] Shay, J. M. personal communication.

[15] Anderson, S. M. 1986. The tall-grass prairie community in Manitoba. Rep. for World Wildl. Fund, Wild West Proj., Winnipeg. 97pp.

[16] MDNR. 1983. Five-year report to the legislature on wildlife. Man. Dep. Nat. Resour., Winnipeg. 150pp.

[17] Aireal photographs (MDNR)

[18] Whaley, K. personal communication.

[19] Berger R. personal communication.

available. The information on which these judgements were made is footnoted with Table 3. When more complete and less subjective information becomes available on a given site, or if site characteristics change, the value can be reassessed and replaced in the matrix.

4.2.3 Summary of Site Evaluations

Based on criteria discussed in this chapter and based on the information available on the selected sites, Oak Hammock Marsh WMA offers the greatest potential as a re-establishment site.

Following further analysis of these and other areas, additional potential release sites could be considered.

4.3 SOURCES OF BIRDS FOR TRANSPLANT

There are two distinct sources of birds for transplant: 1) captive propagation and 2) wild-caught birds.

4.3.1 Propagation

Methods for mass propagation of greater prairie chicken have been developed (McEwen et al. 1969, Kruse 1984). The Northern Prairie Wildlife Research Center in Jamestown, North Dakota is the largest propagation facility for greater prairie chicken in North America (A. Kruse pers. comm.). From 1972-1975 a total of 799 birds were raised to eight

weeks of age (Kruse 1984). From 1976-1984 no greater prairie chicken were propagated at the centre. At present the centre maintains only a small captive breeding flock and therefore could not be considered as a source of pen-reared birds for re-establishment at this time.

Based on a survey of nine states (see appendix A) there is no other source of pen-reared birds in North America.

4.3.2 Wild-caught Birds

A survey of nine states determined three potential sources of wild birds for transplant (see appendix A).

1. Kansas
2. Nebraska
3. Oklahoma

Wildlife personnel from all three states indicated that their agencies might provide greater prairie chicken for transplant in return for Manitoba species. Kansas authorities expressed interest in exchanging greater prairie chicken for ruffed grouse (Bonasa umbellus mediana) or river otter (Lutra canadensis), Nebraska for river otter, and Oklahoma for geese, otter, grouse or bear. Kansas authorities also indicated that they could possibly sell from 50 to 100 birds per year (April trapping) at a cost of no less than $100 (U.S) per bird.*

*Subsequent to my survey, information was published which suggests that Kansas would be

willing to trade greater prairie chicken for sharp-tailed grouse (Rogers 1985).

Although response from South Dakota indicated a large and stable population of greater prairie chicken, wildlife authorities in this state are not willing to provide wild birds for transplant.

Of the three states, Nebraska, being the closest, would be the favoured source of birds. Although response to the survey did not indicate an interest in sharp-tailed grouse, a re-establishment study done in Alberta (Nutall 1984) suggested that Nebraska would trade greater prairie chicken for sharp-tailed grouse if the province provided experienced personnel to trap and transfer the birds.

Persons to contact to initiate species transfer are:

Kansas:
Roger Wells
Small Game Biologist
P.O. Box 1525
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4.4 TRANSPLANT PROGRAM

4.4.1 Introduction

Sharp-tailed grouse is the most advantageous species for Manitoba to trade and the following transplant regime is based on the assumption that greater prairie chicken will be obtained in return for sharp-tailed grouse. In the event that sharp-tailed grouse are present in the proposed restoration area, sharp-tailed grouse exchanged for greater prairie chicken should be taken from this area. Taking sharp-tailed grouse from the release site and surrounding area will provide birds for exchange as well as reducing problems of competition and hybridization. A second advantage of trading sharp-tailed grouse is that the penned sharp-tailed grouse can first be used to reduce the dispersion of transplanted greater prairie chicken. Finally, requirements for the trapping and transport of sharp-tailed grouse equates with those for greater prairie chicken simplifying the Province-State agreement.

The numbers of birds indicated throughout this section are estimates of how many birds can be caught, held, and transported. These numbers were used in estimating labour requirements but should be exceeded where possible.

4.4.2 Transplant Methods

4.4.2.1 Capture, Holding and Transport

In a study in New Mexico comparing four livetrapping techniques (cannon net, vertical mist net, inclined mist net and baited drop net), Davis et al. (1980) found that cannon nets captured the largest number of birds and were the most efficient. Of the four techniques, cannon nets were easiest to prepare, maintain, and operate. Toepfer (1978) used two 60 X 60 ft, 1 inch mesh (18.3 X 18.3 m, 2.6 cm mesh) rocket nets. Rocket nets were placed adjacent to or opposite one another depending on the distribution and movement of hens on booming grounds. Davis et al. (1980) found that the best results in trapping females were obtained on the lek territories occupied by central dominant males.

Silvy and Robel (1967) found that the use of tape-recorded vocalizations from booming grounds greatly enhanced trapping success (cannon nets on booming grounds). Greater prairie chicken were attracted to the booming grounds when the tape was played and returned to the lek more quickly after a disturbance if the tape was played. Both greater prairie chicken and sharp-tailed grouse will be captured on leks in spring using cannon nets and taped vocalizations from booming or dancing grounds.

Two phases of the transplant regime require that birds be transplanted during the summer molt in August. Toepfer

(pers. comm.) could not "emphasize enough that the best way to hold birds in release area is to release them in the summer during the molt". Toepfer (pers. comm.) warned that seven states interested in re-establishing greater prairie chicken, although given his information, chose other methods of release. None of these attempts have been successful (Toepfer pers. comm.). This two-step plan involves using cannon nets to capture cocks in the spring when they are concentrated on the booming grounds, radio-tagging the birds, releasing them in place and then recapturing them during the summer molt using radio-telemetry and night lighting (Toepfer 1983). In order to locate 30 living birds during the summer molt, at least 38 birds should be tagged. Additional mortality is also likely to occur during the transfer to the release site.

Captured birds for all four phases should be marked for future identification.

The sharp-tailed grouse captured in Manitoba should be transported to the greater prairie chicken release site and held in pens. Rogers (1985) observed males preventing females from eating and attributed some deaths of birds held in captivity to sexual hierarchy leading to malnutrition. He recommended that sexes be held separately.

The following is a description of the holding pens used in the Crex Meadows project (Toepfer 1975). The pen

described should be modified by using 2 X 1 inch (5.1 X 2.5 cm) welded wire mesh rather than chicken wire.

- 150 X 130 X 6 ft (45.7 X 39.6 X 1.8 m) made of 1 inch (2.6 cm) galvanized chicken wire supported by 5 inch (12.8 cm) diameter wooden poles.
- An additional 2ft. (.6 m) of wire should be buried below the ground.
- Top of pen covered by 2 inch (5.1 cm) mesh, flexible, nylon, black netting.
- 12 volt electric fence encircling pen to prevent mammals from climbing up the sides.
- 10 inch (25.4 cm) wire spikes made of 9 gauge wire placed on top of each supporting pole to prevent raptors form perching.
- Centre partition of chicken wire dividing pen in half lengthwise to separate sexes.
- 8, 4 X 65 ft. (1.2 X 19.8 m) strips of nylon netting hung from top of pen to prevent birds from flying the full length of the pen and injuring themselves on the wire mesh.
- Three straw bale huts, with 3 X 5 ft. (.9 X 1.5 m) wooden tops placed inside pen to provide shade and shelter.

If the total number of greater prairie chicken required can not be trapped at one location within a few hours, trapping should be conducted at more than one location simultaneously. Birds should be transported as soon as possible. Birds should be transported in separate, small, cardboard boxes to eliminate injurious contact (Toepfer 1975). The distance from capture to release site will require that the birds be airlifted. A chartered plane is recommended to reduce transport time and to facilitate landing at airfields nearest to the capture and release sites.

4.4.2.2 Release Methods

If a natural lek is not located in the release area, Nuttall (1984) recommends that birds be released onto an artificial lek. Baydack (1986) created artificial sharp-tailed grouse leks using criteria listed in Table 4. A lawn mower was used to mow vegetation to the spring measurement mean and ground cover was removed to achieve the desired composition. The characteristics determined by Baydack (1986) are for sharp-tailed grouse. However as discussed in 2.2.2, researchers have found no significant difference between area used for display by the two species.

Recommendations from a transplant project (Toepfer 1983) and from a feasibility of re-establishment study (Nuttall 1984) advocate a gentle or easy release. This would involve holding birds overnight in large pens on the release site with sexes segregated. (For pen dimensions refer to previous section.) In a gentle release, the holding pen is opened slowly from a distance, using a cord. It is recommended that the males be released first so that they have time to establish territories and start displaying before the females are released the following morning (Nuttall 1984).

Toepfer (1983) found that the presence of birds in holding pens at the release site reduced the movement of the released wild birds. I recommend this technique for

TABLE 4

Environmental characteristics of sharp-tailed grouse study leks, Carberry Sand Hills, Manitoba (Baydack 1986).

Component	Measurement
Next nearest lek	1.7 - 2.9 km, $\bar{x}$ = 2.2 km
Orientation	NW to SE
Area	100-1220 m^2, $\bar{x}$ = 446 m^2
Surrounding terrain	Flat to undulating, generally lower elevation
Slope	≤1% over display area
Vegetation height in spring	7 - 13 cm, $\bar{x}$ = 10.4 cm
Ground cover in spring	
shrub	<1%
forb	15%
grass	70%
bare ground	15%
Visibility	Unrestricted in all directions, 70-80% on display area.
Distance to escape cover	≤500 m
Distance to perching trees	≤400 m

Manitoba. Since pen-reared birds are not available at this time the sharp-tailed grouse should be kept at the release site in holding pens for two weeks following the first release of greater prairie chickens then transported to the cooperating state and released.

4.4.3 Transplant Schedule

The transplant schedule that follows is presented as a flow chart in four phases. Timing of activities is divided into spring, summer and fall. Locations of activities are either Manitoba or the cooperating state (referred to as "State").

YEAR 1.

Spring	State:	-capture, radio-tag, and release, 38 male greater prairie chicken on lek.
	Manitoba:	-capture 38 sharp-tailed grouse on leks and hold in pens at release site.
Summer	State:	-recapture male greater prairie chicken, remove radio-tag, and transport to Manitoba.
	Manitoba:	-release greater prairie chicken -two weeks following release of greater prairie chicken, transport sharp-tailed grouse to State.
Fall	Manitoba:	-determine number of greater prairie chicken in re-establishment area.

YEAR 2.

Spring	State:	-capture 50 greater prairie chicken on leks.

-radio-tag and release half (15) males,
-transport all females (20) and remaining half of males to Manitoba.

Manitoba: -determine number of greater prairie chicken in re-establishment area.
-capture 50 sharp-tailed grouse on leks and transport to state.
-release 35 greater prairie chicken.

Summer State: -recapture male greater prairie chicken, remove radio-tags, and transport to Manitoba.

Manitoba: -release 15 male greater prairie chicken

Fall Manitoba: -determine number of greater prairie chicken in re-establisment area.

YEAR 3.

Spring State: -capture 50 greater prairie chicken on leks with as many females as possible and transport to Manitoba.*

*Rogers (1985) suggests that once males are established in the area, transplanting should attempt to skew the sex ratio towards females.

Manitoba: -determine number of greater prairie chicken in re-establishment area.
-capture 50 sharp-tailed grouse on leks and transport to State.

Fall Manitoba: -determine number of greater prairie chicken in re-establishment area.

YEAR 4.

-maintain population of greater prairie chicken in re-establishment area by repeating year 3 if numbers are dropping.

4.5 RE-ESTABLISHMENT COSTS

4.5.1 Transplant Costs

The costs estimated for transplant are made with the assumption that greater prairie chicken will be traded one for one for sharp-tailed grouse and that the state supplying the greater prairie chicken will supply the equipment and manpower for capturing the birds. The costs estimated will therefore include the cost of capturing, holding and transporting approximately 140 sharp-tailed grouse and monitoring greater prairie chicken numbers on the re-establishment area over a three year per. As well, although I assume the cooperating state agency will provide manpower and equipment for spring trapping, radio equipment and manpower for transplant during the summer molt should be provided by Manitoba.

4.5.1.1 Equipment

- 4 rocket nets
  - Winn-Star, Inc., Herrin, Illinois.
  - 60 X 40 ft. (18.3 X 12.2 m) net, $452.00 U.S. ($602.67 Can.)
  - rockets (6/net), $85.00 U.S. ($113.33 Can.) each
  - charges (case of 100), $300.00 U.S. ($400.00 Can)

- 38 radio transmitters
  - Telemetry Systems, Inc., Mequon, Wisconsin.
  - model RS50-1SM-3X. $112.50 U.S. ($150.00 Can.) each

- 2 radio receivers and antennas
  - receiver, model TR-2-148/150. $1,214.00 U.S. ($1,618.67 Can.) each
  - antenna, model RA-2AK. $71.00 U.S. ($94.67 Can.) each

- 1 holding pen
  - welded wire mesh
    - Victor Fox Food, Winnipeg, Manitoba.
    - 2 X 1 inch (5.1 X 2.5 cm) mesh, - 690 X 8 ft. (210.3 X 2.4 m)/pen. $1,800.00/pen
  - electric fence
    - Feed Rite, Winnipeg, Manitoba.
    - 12 volt, 3 strand, with insulators and fiberglass posts. $295.00
  - 2 inch (5.1 cm) mesh, flexible, black, nylon netting
    - Leckie's Lakefish Net and Twine Ltd., Winnipeg, Manitoba.
    - 21,580 ft^2 (2,005 m^2)/pen = 550 lbs.(280 kg)/pen
    - $7.44/lb ($16.40/kg) = $4,100/pen
  - Total cost/pen = $6195.00

Note: In order to reduce the cost of holding the greater prairie chickens, a temporary divider could be placed in one end of the holding pen containing the sharp-tailed grouse. Effects of overcrowding would be minimal since the prairie chickens will transported to the holding pen and released the following morning.

4.5.1.2 Transportation

- 4 X 4 pick-up truck to transport equipment, wildlife personnel and birds to and from the trapping and release area. 2 month/year, $750/month.

- Air time to locate radio-tagged males during summer
  - 4 hours/years 1 and 2.
  - $200/hour (D. G. Barber, pers. comm.)

- Chartered aircraft: 2 return flights/years 1 and 2, 1 return flight year 3
  - Air West, Winnipeg, Manitoba.
  - Winnipeg to Lincoln, Nebraska return. $2,575.00

4.5.1.3 Labour

Table 5 shows the labour requirements for the transplant estimated in man-hours (adapted from Nuttall 1984).

The following is a list of personnel required for the transplant over a three year period with their respective estimated wage:

- 1 Wildlife biologist - $16.83 per hour
- 2 Experienced field technicians - $15.51 per hour
- 2 Field assistants $9.03 per hour

4.5.1.4 Summary of Transplant Costs

- Equipment	$27,500
- Transportation	$19,000
- Labour	$14,000
- Total	$60,500

TABLE 5

Estimate of Man-hours Required for Transplant

Personnel	1st Year spring cap. 38 stg[1]	1st Year summer cap./rel. 38 gpc[2]	2nd Year spring cap./rel. 50 stg/35 gpc	2nd Year summer cap./rel. 15 gpc	3rd Year spring cap./rel. 50 stg/50 gpc	monitor gpc #s during 3 years	totals
Manitoba wildl. biologist to act as supervisor and to locate suitable sharp-tailed grouse trapping sites.	10	15	10	10	10	-	55
2 Experienced field techs. to set and operate cannon nets, and supervise all handling, banding, and radio telemetry procedures.	40	160	100	100	100	-	500
2 Field assistants, preferably students or techs. with grouse experience.	40	160	100	100	100	75	575
totals	90	335	210	210	210	75	1130

[1] Spring trapping of sharp-tailed grouse in Manitoba.
[2] Summer capture of male greater prairie chicken in cooperating state using radio telemetry.

4.5.2 Habitat Management Costs for Re-establishment

The costs of habitat management before and after the transplant can not be determined before a re-establishment site is chosen. Management costs will vary depending on the geographic location and current condition of grassland in the re-establishment area. For reference, prescribed burns conducted on Oak Hammock Marsh WMA, using 2 field technicians and 4 assistants, would cost approximately $1,500/100 ha (K. Whaley, pers. comm.).

Habitat management for greater prairie chicken as described in section 2.3 will benefit the entire tall-grass prairie community. Therefore, the entire cost of habitat management should not be charged to the cost of re-establishing greater prairie chicken.

Chapter V

FEASIBILITY

5.1 CONCLUSIONS

5.1.1 Biological Feasibility

1. Manitoba contains areas that could provide suitable habitat for a transplanted population of greater prairie chicken.
2. The majority of prior attempts at re-establishing greater prairie chicken in other areas of North America have been unsucessful.
3. At present there is no source of pen-reared greater prairie chickens for a re-establishment project. Kansas, Nebraska and Oklahoma are sources of wild birds for transplant.
4. I have developed a re-establishment plan for Manitoba. The plan employs the methods which offer the greatest probability of success based on a review of methods and results of past re-establishment attempts.
5. The re-establishment of greater prairie chicken in Manitoba is biologically feasible. However, given that many variables are as yet unknown and therefore

beyond control, the probability of successful re-establishment is low.

5.1.2 Cost Analysis

The previous chapter provided an estimate of the cost of a transplant project. According to this estimate, each of the 140 greater prairie chicken transplanted to Manitoba would cost approximately $435 in equipment, transportation and labour totalling a minimum cost of $60,500. Ultimately the economic feasibility of re-establishing greater prairie chicken depends on what priority the decision makers of Manitoba place on such a program, and the availability of funds.

5.2 RECOMMENDATIONS

The greater prairie chicken is only one species in the grassland ecosystem and due to the high cost and low probability of success of a transplant project I recommend against the implementation of a program that has as its single objective the restoration of greater prairie chicken.

However, the re-establishment of greater prairie chicken might be viewed as part of a broader objective. A restoration program for the tallgrass prairie community would benefit a re-establishment project for greater prairie chicken but would have as its ultimate goal the restoration

of the ecosystem as a whole. I recommend the implementation of a grassland restoration program that has the re-establishment of greater prairie chicken as one of many objectives.

5.2.1 Further Research Needs

Before a re-establishment project for greater prairie chicken is initiated, I recommend further research to:

1. Increase the amount of information available for evaluating potential re-establishment sites in order to update the site evaluation matrix (Table 3).
2. For those areas scoring high for site suitability determine: species composition; height and density of vegetation; and degree of restoration needed to provide habitat requirments.
3. Monitor recent release programs in U.S. to determine success and relate the information to potential success in Manitoba if a release were undertaken.

LITERATURE CITED

Aldrich, J. W. 1963. Geographic orientation of North American Tetraonidae. J. Wildl. Manage. 27:529-545.

Ammann, G. A. 1957. The prairie grouse of Michigan. Mich. Dep. Conserv. Tech. Bull. 200 pp.

Anderson, R. K. 1969. Prairie chicken responses to changing booming ground cover type and height. J. Wildl. Manage. 33:636-643.

Anderson, S. M. 1986. The tall-grass prairie community in Manitoba. Rep. for World Wildl. Fund, Wild West Proj., Winnipeg. 97pp.

Arthaud, F. L. 1970. Land use and prairie chicken populations in southwestern Missouri. Trans. Kansas Acad. Sci. 73:267-276.

Baydack, R. K. 1986. Sharp-tailed grouse response to lek disturbance in the Carberry Sand Hills of Manitoba. Ph. D. thesis. Colorado State Univ., Fort Collins. 83 pp.

Bent, A. C. 1932. Life histories of North American gallinaceous birds. Dover Publications Inc., New York. 490 pp.

Berger, D. D., F. Hamerstrom, and F. N. Hamerstrom Jr. 1963. The effects of raptors on prairie chickens on booming grounds. J. Wildl. Manage. 27:788-791.

Bidlake, L. J. 1978a. A management plan for the Broomhill wildlife area. Man. Dep. Nat. Resour. Wildl. Rep. 78-31, Brandon. 21pp.

_____. 1978b. A management plan for the Lauder Sandhills wildlife area. Man. Dep. Nat. Resour. Wildl. Rep. 78-37, Brandon. 35pp.

_____. 1978c. A management plan for the Brandon Hills wildlife area. Man. Dep. Nat. Resour. Wildl. Rep. 78-30, Brandon. 17pp.

_____. 1978d. A management plan for the Souris River Bend wildlife area. Man. Dep. Nat. Resour. Wildl. Rep. 78-32, Brandon. 33pp.

Bowman, T. J., and R. J. Robel. 1977. Brood break-up, dispersal, mobility, and mortality of juvenile prairie chickens. J. Wildl. Manage. 41:27-34.

Bradbury, J. W., and R. M. Gibson. 1983. Leks and mate choice. Pages 109-138 in P. Bateson, ed. Mate Choice. Univ. Cambridge Press, Cambridge.

Brazier, F. 1972a. A probable pinnated grouse near Mortlach. Blue Jay 30:31-32.

_____. 1972b. Greater prairie chicken sighted again. Blue Jay 30:198-199.

Breckenridge, W. J. 1929. The booming of the prairie chicken. Auk 46:540-543.

Brown, D. E. 1978. Grazing, grassland cover, and gamebirds. Trans. N. Am. Wildl. and Nat. Resour. Conf. 43:477-485.

Buhnerkempe, J. E., W. R. Edwards, D. R. Vance, and R. L. Westemeier. 1984. Effects of residual vegetation on Prairie-chicken nest placement and success. Wildl. Soc Bull. 12:382-386.

Carson, B. E. 1986. An interpretive plan for tall grass prairie restoration at Beaudry Provincial Heritage Park. Master Nat. Resour. Manage. Practicum. Univ. Manitoba, Winnipeg. 184pp.

Christisen, D. M. 1969. National status and management of the greater prairie chicken. Trans. N. Am. Wildl. and Nat. Resour. Conf. 34:207:217.

_____. 1978. Significance of native prairie to greater prairie chicken (Tympanuchus cupido pinnatus) survival in Missouri. Pages 250-254 in R. L. Stuckey and K. J. Resse, eds. Proc. 6th N. Am. Prairie Conf. Ohio State Univ. Columbus, Ohio.

COSEWIC. 1979.Greater prairie chicken (Tympanuchus cupido pinnatus).

COSEWIC. 1985. Species classified by committee on the status of endangered wildlife in Canada.

Davis, C. A., T. Z. Riley, J. F. Schwartz, H. R. Suminski, and M. J. Wisdom. 1980. Livetrapping female prairie chickens on spring leks. Pages 64-67 in P. A. Vohs, Jr., and F. L. Knopf, eds. Proc. Prairie Grouse Symp., Oklahoma State Univ., Stillwater.

Dixon, R. 1979. A remote sensing classification of vegetation for selected areas of C.F.B. Shilo. Man. Dep. Mines, Nat. Resour., and Environ. Tech. Rep. 79-4, Winnipeg. 39pp.

Drobney, R. D., and R. D. Sparrowe. 1977. Land use relationships and movements of greater prairie chicken in Missouri. Trans. Missouri Acad. Sci. 10:146-160.

Evans, K. E. 1968. Characteristic and habitat requirements for greater prairie chicken and sharp-tailed grouse - a review of the literature. U. S. Dep. Agric., For. Serv., Conserv. Res. Rep. 12. 32 pp.

_____, and D. L. Gilbert. 1969. A method for evaluating greater prairie chickens habitat in Colorado. J. Wildl. Manage. 33:643-649.

George, R. A., A. L. Farris, C. C. Schwartz, D. D. Hamburg, and J. C. Coffey, 1979. Native prairie grass pastures as nest cover for upland birds. Wildl. Soc. Bull. 7:4-9.

Godfrey, W. E. 1966. The birds of Canada. Nat. Mus. Can. Bull. No. 203, Biol. Ser. No. 73. 428 pp.

Hamerstrom, F. N., Jr. 1939. A study of Wisconsin prairie chickens and sharp-tailed grouse. Wilson Bull. 51:105-120.

_____, and F. Hamerstrom. 1949. Daily and seasonal movements of Wisconsin prairie chickens. Auk 66:313-337

_____, _____. 1961. Status and problems of North American grouse. Wilson Bull. 73:284-294.

_____, _____. 1973. The prairie chicken in Wisconsin. Wisconsin Dep. Nat. Resour. Tech. Bull. No. 64. 52 pp.

Hamerstrom, F., D. D. Berger, and F. N. Hamerstrom Jr. 1965. The effects of mammals on prairie chickens on booming grounds. J. Wildl. Manage. 29:536-542.

Hamerstrom, F. N., Jr., F. Hopkins, and A. J. Rinzel. 1941. An experimental study of browse as a winter diet for prairie chicken. Wilson Bull. 53:185-195.

_____, O. E. Mattson, and F. Hamerstrom. 1957. A guide to prairie chicken management. Wisconsin Conserv. Dep. Tech. Wildl. Bull. No. 15. 128 pp.

Harger, E. M. 1956. Behaviour of a ring-necked pheasant on a prairie chicken booming ground. Wilson Bull. 68:70-71.

Hatch, D. M. 1973. Greater prairie chicken at Leader, Saskatchewan. Blue Jay 31:55-56.

Hjorth, I. 1970. Reproductive behavior in Tetraonidae, with special reference to males. Viltrevy 7:185-596.

Jacobs, K. F. 1959. Restoration of the greater prairie chicken. Oklahoma Dept. of Wildl. Conserv. P-R Proj. Rep. W-65-R. 42pp.

Johnsgard, P. A. 1973. Grouse and quails of North America. Univ. of Nebraska Press, Lincoln. 553 pp.

_____. 1983. The grouse of the world. Univ. Nebraska Press, Lincoln. 413 pp.

_____, and R. W. Wood. 1968. Distributional changes and interactions between prairie chickens and sharp-tailed grouse in the midwest. Wilson Bull. 80:173-188.

Johnston, A., and S. Smoliak. 1976. Settlement of the grasslands and the greater prairie chicken. Blue Jay 34:153-156.

Jones, R. E. 1963. Identification and analysis of lesser and greater prairie chicken habitat. J. Wildl. Manage. 27:757-778.

Kirsch, L. M. 1974. Habitat management considerations for prairie chickens. Wildl. Soc. Bull. 2:124-129.

_____, A. T. Klett, and H. W. Miller. 1973. Land use and prairie grouse relationships in N. Dak. J. Wildl. Manage. 37:449-453.

_____, H. F. Duebbert, and A. D. Kruse. 1978. Effects of grazing and haying on habitats of upland nesting birds. Trans. N. Am. Wildl. and Nat. Resour. Conf. 43:486-497.

Kobriger, G. D. 1965. Status, movements, habitats, and foods of prairie grouse on a sandhills refuge. J. Wildl. Manage. 29:788-800.

Korschgen, L. J. 1962. Food habits of greater prairie chickens in Missouri. Am. Midl. Nat. 68:307-318.

Kruse, A. D. 1973. Prairie chicken restoration projects. pp. 40-46 in W. D. Svedarsky and T. Wolfe, eds. Proceedings of a conference on prairie chicken in Minnesota. Univ. Minnesota, Crookston.

_____. 1984. Simplified methods for mass propagation of greater prairie chickens. Game Bird Breeders, Aviculturists, Zoologists and Conservationists' Gazette. 33:8-15.

Lumsden, H. G. 1965. Displays of the sharptail grouse. Ontario Dep. Lands and Forests Tech. Ser. Res. Rep. 66. 68 pp.

_____. 1966. The prairie chicken in southwestern Ontario. Can. Field Nat. 80:33-45.

_____. 1970. A hybrid population of prairie grouse on Manitoulin Island, Ontario. Winnipeg, Manitoba, Proc. 32nd Midwest Fish Wildl. Conf.

Mace, P. 1964. Post-release observations - greater prairie chickens. Oklahoma Dept. Wildl. Conser. P-R Proj. Rep. W-82-R-3. 3pp.

Martin, S. A., and F. L. Knopf. 1980. Distribution and numbers of greater prairie chickens in Oklahoma. Pages 68-70 in P. A. Vohs, Jr., and F. L. Knopf, eds. Proc. Prairie Grouse Symp. Oklahoma State Univ., Stillwater.

MCC. 1980. Native grasses for wildlife. Missouri Conserv. Comm.4pp.

McEwen, L. C., D. B. Knapp, and E. A. Hillard. 1969. Propagation of grouse in captivity. J. Wildl. Manage. 33:276-283.

McPhail, K. E. 1978. A management plan for the Pierson wildlife area. Man. Dep. Nat. Resour. Wildl. Rep. 78-38, Brandon. 13pp.

MDC. 1984. Species management plan for the greater prairie chicken in Missouri. Missouri Dep. Conserv., Wildl. Div., Jefferson City. 91pp.

MDNR. 1983. Five-year report to the legislature on wildlife. Manitoba Dep. Nat. Resour., Winnipeg. 150 pp.

Miller, G. 1984. Prairie-chickens get new home. Research News. Colorado Div. Wildl. pp. 3-4.

Miller, H. W. 1960. Restocking of the greater prairie chicken. Proc. Nat. Prairie Chicken Conference.

Mohler, L. L. 1952. Fall and winter habits of prairie chickens in Nebraska. J. Wildl. Manage. 16:9-23.

Moran, R. J. 1966. Predation on a greater prairie chicken by a goshawk. Auk 83:137.

Nuttall, P. 1984. The feasiblity of reintroducing a viable population of greater prairie chickens (Tympanuchus cupido pinnatus) in Alberta. IEC Beak Consultants, Ltd. for Alberta Fish and Wildl. Div. 67 pp.

Patimore, J. H. 1985. The feasibility of reintroducing the swift fox to southwestern Manitoba. Master Nat. Resour. Manage. Practicum. Univ. Manitoba, Winnipeg. 102pp.

PFRA. 1987. Memo to CWS. re: Community pasture vegetation inventory evaluation.

Renhowe, B. A. 1968. Food habits of the sharp-tailed grouse and the greater prairie chicken in western South Dakota. M.S. Thesis, South Dakota State Univ. 80 pp.

Robel, R. J. 1970. Possible role of behavior in regulating greater prairie chicken populations. J. Wildl. Manage. 34:306-312.

_____, J. N. Briggs, J. J. Cebula, N. J. Silvy, C. E. Viers, and P. G. Watt. 1970. Greater prairie chicken ranges, movements and habitat usage in Kansas. J. Wildl. Manage. 34:286-306.

Robertson, K. 1980. Changes occurring in Nebraska's prairie grouse habitat. Pages 52-54 in P. A. Vohs, Jr., and F. L. Knopf, eds. Proc. Prairie Grouse Symp. Oklahoma State Univ., Stillwater.

Rogers, R. 1985. Re-establishment of sharp-tailed grouse in western Kansas. Fed. Aid Project FW.-9-P-2, Kansas Fish and Game Commission. 7pp.

Rowan, W. 1926. Comments on two hybrid grouse and on the occurrence of Tympanuchus americanus americanus in the Province of Alberta. Auk 43:333-336.

Salt, W. R., and J. R. Salt. 1983. The birds of Alberta. 3rd ed. Hartig Publishers, Edmonton. 512 pp.

Sanderson, G. C., and W. R. Edwards. 1966. Efforts to prevent the extinction of the prairie chicken in Illinois. Trans. Ill. Acad. Sci. 54:326-333.

Schmidt, F. J. 1936. Winter foods of the sharp-tailed grouse and pinnated grouse in Wisconsin. Wilson Bull. 48:186-203.

Sharp, W. M. 1957. Social and range dominance in gallinaceous birds - pheasants and prairie grouse. J. Wildl. Manage. 21:242-244.

Sharpe, R. S. 1968. The evolutionary relationships and comparative behavior of prairie chickens. Ph.D. Thesis, Univ. of Nebraska, Lincoln.

Shoemaker, H. H. 1964. Report on studiers of captive prairie chickens. Illinois Wildlife. Illinois Dept. Conserv. 19(3):6-9. _____. 1965. Recent progress in rearing and restocking greater prairie chicken in Illinois. Paper presented at Sixth Conf. Prairie Grouse Tech. Counc. Warroad, Minn.

Short, L. L., Jr. 1967. A review of the genera of grouse (Aves, Tetraoninae). Am. Museum Novitates 2289:1-39.

Silvy, N. J., and R. R. Robel. 1967. Recordings used to help trap booming greater prairie chickens. J. Wildl. Manage. 31:370-373.

Sparling, D. W. 1979. Reproductive isolating mechanisms and communication in prairie chickens (Tympanuchus cupido) and sharp-tailed grouse (Pedioecetes phasianellus). Ph. D. thesis. Univ. of North Dakota, Grand Forks. 238 pp.

_____. 1980. Hybridization and taxonomic status of greater prairie chickens and sharp-tailed grouse:Hybridization in grouse. Prairie Nat. 12:92-102.

Svedarsky, W. D. 1979. Spring and summer ecology of female greater prairie chickens in Northwestern Minnesota. Ph. D. thesis. Univ. of North Dakota, Grand Forks. 166 pp.

_____. 1983. Reproductive chronology of greater prairie chicken in Minnesota and recommendations for censusing and nest searching. Prairie Nat. 15:120-124.

_____, and T. J. Kalahar. 1980. Female sharp-tailed grouse copulates with a greater prairie chicken in Minnesota. Wilson Bull. 92:260-261.

Tester, J. R., and W. H. Marshall. 1962. Minnesota prairie chicken management techniques and their wildlife implications. Tran. N. Am. Wildl. Conf. 27:267-287.

Thompson, E. E. 1891. The birds of Manitoba. Smithsonian Institution, Government Printing Office, Washington. 643 pp.

Toepfer, J. E. 1975. Preliminary progress report: reintroduction of greater prairie chickens into the Crex Meadows Wildlife Area, Burnett County, Wisconsin. Wisconsin Dep. Nat. Resour. unpub. rep. 24pp

_____. 1976. Progress report: reintroduction of greater prairie chickens into the Crex Meadows Wildlife Area, Burnett County, Wisconsin. Wisconsin Dep. Nat. Resour. unpub. rep. 22pp.

_____. 1978. Research report: reintroduction of greater prairie chickens into the Crex Meadows Wildlife Area, Burnett County, Wisconsin. Wisconsin Dep. Nat. Resour. unpub. rep. 13pp.

_____. 1983. Reintroduction of greater prairie chickens into the Crex Meadows Wildlife Area, Burnett County, Wisconsin. Wisconsin Dep. Nat. Resour. unpub. rep. 5pp. (1979 abstract and 1983 addendum)

Toney, T. E. 1980. Foods of prairie chicken on managed native prairie. Pages 81-84 in P. A. Vohs, Jr., and F. L. Knopf, eds. Proc. Prairie Grouse Symp. Oklahoma State Univ., Stillwater.

Vance, D. R. 1976. Changes in land use and wildlife populations in southeastern Illinois. Wildl. Soc. Bull. 4:11-15.

_____, and R. L. Westemeier. 1979. Interactions of pheasants and prairie chickens in Illinois. Wildl. Soc. Bull. 7:221-225.

Wapple, G. J. 1977. Greater prairie chicken near Ruthilda Sask. Blue Jay 35:91.

Westemeier, R. L. 1971. The history and ecology of prairie chickens in central Wisconsin. Univ. Wisconsin, Col. Ag. and Life Sci., Res. Bull. No. 281. 63 pp.

_____. 1980. Greater prairie chicken status and management -- 1968-1979. pp.8-17 in P. A. Vohs, Jr., and F. L. Knopf, eds. Proc. Prairie Grouse Symp., Oklahoma State Univ., Stillwater.

WWF. 1987. Lets leave some wild in the west: prospectus for a prairie conservation plan. World Wildlife Fund, Calgary. 12pp.

Wrakestraw, G. F. 1960. Trapping and transplanting of game animals, game birds, and fur bearers. Wyoming Game and Fish Dept. P-R Proj. Rep. W-13-D-13. 2 pp.

Yeatter, R. E. 1963. Population responses of prairie chickens to land-use changes in Illinois. J. Wildl. Manage. 27:739-757.

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Appendix A

SURVEY OF POTENTIAL SOURCES OF BIRDS FOR TRANSPLANT

1. What is the estimated population of greater prairie chicken in your state?

2. Is the population increasing or decreasing?

3. Would your agency be willing to sell birds for transplant to the Manitoba Department of Natural resources? If so, how many could you sell and at what price?

4. Would your agency be interested in trading greater prairie chicken for any of our wildlife species? If so, what species of wildlife would you be interested in?

5. Is there a source of pen reared birds in your state (private or state controlled)?