SURVIVAL, REPRODUCTION, MOVEMENT, AND HABITAT USE OF FEMALE EASTERN WILD TURKEYS (*MELEAGRIS GALLOPAVO SILVESTRIS*) IN MANITOBA'S PEMBINA VALLEY

by

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A Thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

In partial fulfillment of the requirements of the degree of

MASTER OF SCIENCE

Department of Environment and Geography

University of Manitoba

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ABSTRACT

Vital rates and movement patterns of eastern wild turkeys (*Meleagris gallopavo silvestris*) have never been studied at the northern extent of their North American range in Manitoba, Canada. Using radio telemetry during 2011 and 2012, this study collected estimates of female spring/summer survival, reproductive success, dispersal, home range size, and habitat use. Females had a 53% survival probability, 82% nesting frequency, 29% nesting success, 35% hen success, 11.3 eggs/clutch, 89% hatching success, and a natality rate of 2.3. Winter weather and relatively high predator numbers appear to have caused annual variation in survival and hen success. Spring dispersal distances and home ranges averaged 8.2 km and 554.4 ha, respectively. Home ranges were selected in relation to forests, cattle feedlots, and grasslands; while within home ranges, individuals selected areas close to grasslands, forests, and intermittent streams. These results can be used when modeling current populations, managing harvest, and structuring future releases.

ACKNOWLEDGEMENTS

Going back to school and pursuing this degree was not easy, to say the least, but even though were a few bumps in the road along the way, I am truly grateful for the journey and everything that I've learnt, in school and in life.

Thank you Manitoba Conservation and Water Stewardship for initiating and funding a large portion of this research, and employing me as a summer student during my two field seasons in the Pembina Valley. I also appreciate funding from the National Wild Turkey Federation (NWTF) Canada Super Fund, Manitoba Wildlife Federation, Wild Gobblers Unlimited, Safari Club International Foundation, Alice Chambers-Hyacinth Colomb Student Assistantship, and the Richard C. Goulden Memorial Award. Thank you Ducks Unlimited Canada for supplying telemetry equipment, and Manitoba Conservation and Water Stewardship's Manitou District for providing field accommodations.

I'd like to thank my advisor Dr. Rick Baydack, and my committee members Frank Baldwin, Brian Joynt, and Dr. Dave Walker for all of their support throughout this process. Thank you Rick, for originally notifying me of this potential project when I emailed you from Edmonton, desperately searching for graduate school opportunities, and for all of the professional development advice that you've provided during my university career. Thank you Frank, for initiating this research, taking me under your wing as your game bird assistant, and mentoring me throughout the course of this project. The direction and advice that you provided during the last few years has been invaluable. Thank you Brian, for sharing your experience with radio-telemetry research, and helping me cut my teeth down to the valley during my first few weeks of monitoring in 2011. Thank you Dave, for sharing your GIS knowledge during both of my degrees, and steering me down the right path with my habitat analysis.

This project would not have been possible without support from my colleagues at Manitoba Conservation and Water Stewardship, and various volunteers from both Pembina Game and Fish, and Wild Gobblers Unlimited. I'd especially like to thank Jim & Tracy Moores, and Eugene Bodykevich for their extensive help with trapping activities. Also, thank you to Laurie & Richard Lea, David & Craig Dymond, and Reg Edwards who allowed access to their farm sites for trapping operations; and to the many landowners that allowed me to chase my turkeys around their properties during my two years in the valley.

I'd like to extend a big thank you to my parents Marlene and Nestor Kiss, and my sister Alana Kolomaya for their love and constant words of encouragement during the past few years. In addition, thank you all of my close friends, who also showed their support, and didn't hesitate to help me let loose and have fun when needed.

Lastly, I'd like to dedicate this thesis to my grandfather, Gerald Sanness. The love for the outdoors and passion for adventure that you shared with me growing up was truly inspiring, and it undoubtedly led me down the path that I travel today.

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CHAPTER 1 – INTRODUCTION

BACKGROUND

The Wild Turkey

The wild turkey (*Meleagris gallopavo*) is the largest member of the avian order Galliformes (Kennamer et al. 1992). Historically endemic to North America, the wild turkey is further classified into five wild sub-species: eastern (*M. g. silvestris*), Merriam's (*M. g. merriami*), Rio Grande (*M. g. intermedia*), Gould's (*M. g. mexicana*), and Florida (*M. g. osceola*). Turkeys and other gallinaceous birds can be characterized by their reliance on cursorial movement, typically only flying short distances, resulting in many species being equipped with strong legs and feet used for running and scratching, and short beaks adapted for pecking at food (Pelham and Dickson 1992).

Wild turkeys are a ground-based forager, commonly feeding on various forms hard mast, grasses, sedges, fruits, seeds, grains, and insects (Hurst 1992). This generalist diet has allowed the turkeys to become established in a variety of habitats across America (Porter 2007), and form an association with agriculture where corn, cereal, pulse, and forage crops provide year-round, non-traditional food sources (Hurst 1992). Despite habitat preferences that differ across its range, in general, all turkeys require access to moisture, trees for roosting, and insect-rich grasses during poult development (Porter 1992). Typically, access to food sources drives daily and seasonal movement patterns, including the grouping of flocks at agricultural sites during the winter months, especially when deep snow is present (Healy 1992). Dispersal from these sites occurs each spring, where hens select ranges suitable for nesting and brood rearing activities, and males seek out receptive hens and compete with other males for the opportunity to mate (Healy 1992). After mating occurs, hens are able to store viable sperm for up to 56 days, allowing them to delay fertilization until nesting conditions are ideal, and fertilize eggs for renesting attempts, without always having to repeat copulation (Blankenship 1992).

Mortality factors and survival rates vary across the wild turkey's range, and are commonly dependent on legal and illegal harvest pressure, predator richness and abundance, and other environmental conditions (Vanguilder 1992). Annual survival rates as low as 15% have been recorded in Virginia, while rates of >70% have been recorded in Massachusetts, Michigan, and Texas (Vanguilder 1992). Common predators across their eastern range include coyote (*Canis latrans*), bobcat (*Lynx rufus*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), great horned owl (*Bubo virginianus*), and various members of the hawk (Accipitridae) family (Miller and Leopold 1992).

As a relatively short-lived species, wild turkey populations exhibit widespread, low-cost reproductive efforts, resulting in reproduction, not survival, having the largest impact on growth rates (Gill 2007, Roberts and Porter 1998). As a ground-nesting bird, turkey nests are susceptible to a number of predators, including red fox, raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), eastern spotted skunk (*Spilogale putorius*), Virginia opossum (*Didelphis virginiana*), American crow (*Corvus brachyrhynchos*), and common raven (*Corvus corax*) (Miller and Leopold 1992). Typically, turkey populations demonstrate high nesting rates (75–100%), renesting after nest predation, and large clutch sizes (~10.3–12.6 eggs) in an attempt to compensate for relatively low nesting success (30.7–62.0%) (Vanguilder 1992). Nesting success, hen success, and production via natality and recruitment can vary between years within a population due to the effects of predation and weather (Palmer et al. 1993).

Ancestral Range

At the time of European colonization, the wild turkey is believed to have occupied parts of 39 current American states and southern Ontario (Kennamer et al. 1992). Numerous accounts of relatively high densities of turkeys were documented throughout the post-colonial period, particularly in the old growth forests of eastern North America (Wright 1915a, Wright 1915b, Wright 1915c). Also documented are reports on the ease at which turkeys could be harvested en masse by early colonists (Wright 1914). Excessive harvest, paired with habitat destruction, eventually extirpated the turkey from southern Ontario and 18 of the 39 American states that it inhabited (Kennamer et al. 1992).

In the post-war era of the 1940's, American fish and wildlife agencies and private conservation groups became interested in restoring wild turkey populations. These groups initiated trap-and-transfer and propagation programs throughout both the turkey's historic range and further north into previously uninhabited areas (Kennamer et al. 1992). The northern extent of the turkey's ancestral range was the southern limit of the Great Lakes in the eastern part of the continent, barely extending north into southern Ontario, and reaching its northern limit on the Great Plains at the southern quarter of Minnesota and southeastern South Dakota (Wunz 1992, Kimmel and Krueger 2007, Mitchell et al. 2011). Snow depths, not temperature, traditionally limited this range, as turkeys cannot typically scratch through powdered snow deeper than 15 cm, and depths exceeding 30 cm limit their movements (Healy 1992). During controlled research on captive, but genetically 'wild' turkeys in southern Minnesota, Haroldson et al. (1998) estimated that individuals can withstand temperatures below -50º C, but for every 10º C drop in mean air temperature below 10.9º C, a flock of 20 female turkeys must find an additional 400 g of food per day, which historically would require scratching through deep snow that accompanied cold temperatures.

The advent of commercialized agricultural practices in North America during the last century allowed the wild turkey to meet these energy requirements and occupy many areas outside of their ancestral range, as applicable food sources became more abundant during periods of prolonged snow (Kimmel and Krueger 2007). Porter et al. (1980) found that a turkey population relying on foraging for natural foods during a severe winter with continuous deep snow levels experienced significant weight loss and >60% mortality, while a population that had access to standing corn during the same severe winter conditions experienced no weight loss and mortality rates of <10%. The Porter et al. (1980) study and others (Vander Haegen et al. 1988, Healy 1992, Kane et al. 2007, Dunton et al. 2008, Haroldson et al. 1998, Restani et al. 2009) have determined that the key to successful introductions in regions that experience severe winter conditions is providing direct and indirect supplemental feeding by installing turkey feeders, leaving standing corn, and/or ensuring general access to food through common agricultural practices, like manure spreading and silage feeding at beef and dairy production sites.

Due to extensive introduction efforts, agricultural expansion, and the wild turkey's ability to thrive in a wide variety of non-traditional habitats (Kennamer et al. 1992, Porter 2007), it now inhabits 49 American states and 6 Canadian provinces with a continental population that was estimated to be between 6.5–6.7 million individuals in 2009 (Tapley et al. 2009). Furthermore, across North America, it is estimated that in fall 2008 and spring 2009, approximately 2.8 million hunters participated in wild turkey hunting seasons (Tapley et al. 2009); a figure that not only represents the importance of this species to North American culture, but also illustrates the need for the continuation of both sound management practices, the assessment of further range expansion, and the need for acceptance and support for these actions from the general public (Dickson 1992).

History in Manitoba

In 1958, with support from the provincial wildlife authority, Wild Gobblers Unlimited, formed by members of 20 game and fish associations across southern Manitoba, Canada, initiated the first release of wild turkeys in the province (Bidlake 1966). Ten eastern wild turkeys were imported from a hatchery in Mandan, North Dakota and released at a farm site south of Miami, Manitoba. Subsequent releases of imported birds took place between 1958 and 1961 at the same farm site in Miami, but also at sites in the Pembina Valley, Morris, Morden, and Thornhill. After the initial releases of imported birds, a trap-and-transfer program was initiated in Manitoba, moving and establishing populations throughout both the Pembina Valley and central southern Manitoba, then eventually into parts of southeastern Manitoba, western Manitoba, and the south Interlake region (Bidlake 1966, Gillespie 2003). Natural dispersal likely also contributed to the establishment of certain sub-populations within the province, including flocks in the Turtle Mountain area, where the closest introductions occurred south of the international border in North Dakota (Bidlake 1966, Wunz 1992). Unauthorized releases of Merriam's wild turkeys have likely resulted in the establishment of hybrid flocks in some areas of the province, as indicated by light buff coloration on the tips of both primary and covert tail feathers, observed sporadically in some flocks (Frank Baldwin, Manitoba Conservation and Water Stewardship, personal communication).

The initial intention of establishing wild turkey populations in Manitoba was to create a harvestable population, however it was not until 1977 that a restricted spring season was established, offering tags to 400 out of approximately 800 applicants (Thompson 1979). Since then, due to continued trap-and-transfer activities, propagation programs, and natural reproduction and dispersal, both turkey populations and interest in turkey hunting have increased. Manitoba currently offers 'open' resident spring and fall seasons in 15 different Game Hunting Areas (GHA's) across southern Manitoba (Figure 1.1), and from 2008-2010, the province sold an average of 1119 wild turkey licenses annually (Baldwin and Ryckman 2010, Baldwin and Ryckman 2011). Hunter questionnaire data from 2009 and 2010 indicates an approximate 55% harvest success rate during the most-popular spring season (Baldwin and Ryckman 2010, Baldwin and Ryckman 2011), which is relatively high when compared to rates in other northern jurisdictions, including a 5-year (2006-2010) average of 32% in Minnesota (Dunton 2010), 22-24% in Wisconsin during 2009 & 2010 (Dhuey et al. 2011), and 40-41% in Michigan during 2009 & 2010 (Frawley 2011).

Historic peaks in wild turkey hunting license sales have been accompanied by an increase in requests for turkey introductions to previously uninhabited areas of Manitoba. As both licensed and subsistence hunting culture declines throughout the world (Peterle 1977, Organ and Fritzell 2000, Peterson 2004), the maintenance of existing and creation of new hunting opportunities, the retention of existing and recruitment of new hunters, and continued support from stakeholders for conservation programs is essential in maintaining a hunting heritage (Adams 2004). Maintaining this heritage extends beyond just keeping hunting as an effective wildlife management tool, as studies have shown a positive association between children growing up around hunting, and other nature-based experiences and an interest in environmentalism during adulthood (Wells and Lekies 2006). For these reasons, in recent years, wildlife managers have focused their efforts on fulfilling some of the introduction requests, and expanding turkey distribution in order to create additional hunting opportunities within the province (Frank Baldwin, Manitoba Conservation and Water Stewardship, personal communication).

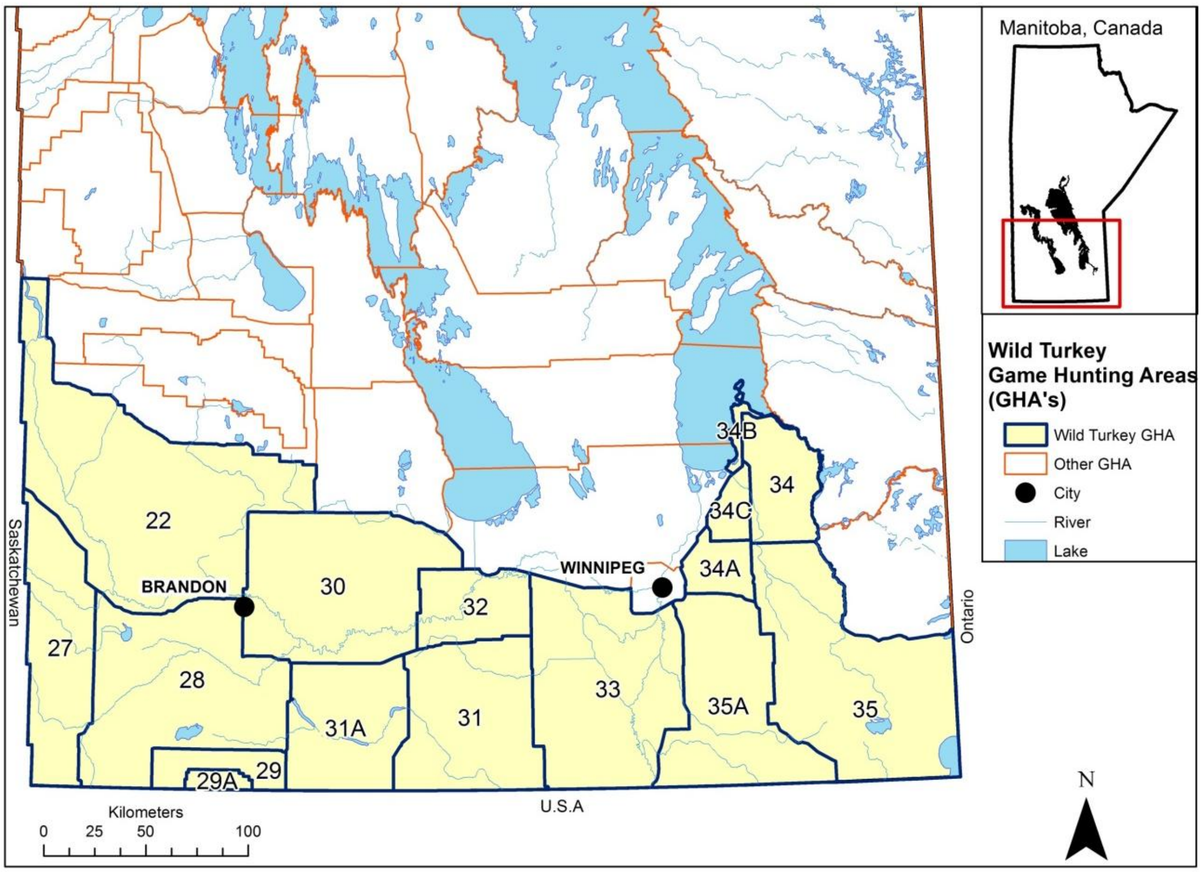

Figure 1.1: Game Hunting Areas (GHA's) in southern Manitoba (see inset box for location within province) where wild turkey hunting seasons (spring and fall) are offered for residents of Manitoba.

PROBLEM STATEMENT

Over the years, data collected through biological surveys has provided a greater understanding of the distribution and diversity of wildlife and associated habitats, and has provided valuable information for natural resource management and protection practices (Allison

2003). Biological data pertaining to population size, vitality, and diversity is useful in assessing the health of both a population and the ecosystem in which it resides (Bolen and Robinson 2003). Estimates of size, birth rates, and death rates are the foundation of population ecology and are used as parameters for population models that assess limiting factors, growth rates, and short/long term population cycles and trends (Bolen and Robinson 2003, Skalski et al. 2005). Information about individual and population movements is also useful in these models, helping to understand the potential for immigration and emigration within a population, and the effect that it may have on growth curves (Vangilder 1992, Bolen and Robinson 2003).

In general, managers still possess very little knowledge on the ecology of northern wild turkey populations (Kimmel and Kruger 2007). Furthermore, biological variables can vary between locations and periods of time (Paisley et al. 1998, Hanson 2011), so information regarding the vital rates and movements of other northern populations may not be directly transferable to Manitoba, stressing the importance of collecting data within the province. Since their introduction in 1958, no research has investigated these aspects of wild turkey biology in Manitoba's population, and previous introductions in the province were based mainly on qualitative habitat assessments and other criteria drawn from studies conducted in dissimilar habitats and climates. The growing interest in expanding turkey populations into what is commonly perceived as 'vacant habitat' necessitates a need to collect data on vital rates and movement patterns from an established population within the province, which will provide valuable baseline information for strategically planning future releases, improving efficiency, and minimizing conflicts with stakeholders.

By trapping, radio-marking, and monitoring female wild turkeys in Manitoba's Pembina Valley, I sought to acquire basic biological information that would benefit the long-term management of this species in the province. The primary objectives of my study were:

- Obtain baseline estimates of female wild turkey vital rates that will prove useful when judging the relative status of populations and assessing important limiting factors within the province. These rates include:
    - Spring/summer survival probability
    - Cause-specific mortality
    - Reproductive effort and success
    - Productivity through natality
- Estimate movement capability of female wild turkeys, for use when planning future introductions and relocations that reduce human-wildlife conflicts, setting hunting season dates, and understanding the carrying capacity of habitats that are currently occupied within the province. The study will estimate:
    - The timing and distances of spring dispersal from wintering sites
    - Spring/summer home range size
- Investigate female wild turkey habitat-use, during the nesting and brood rearing periods, to help explain what made past introductions successful and qualify other areas for introductions.

RESEARCH RATIONALE

While expanding Manitoba's wild turkey population has produced many societal and economic benefits within the province, throughout North America the introduction of wildlife species outside of their natural range has in some cases caused significant negative economic and environmental impacts (Duncan et al. 2003). Before commencing any introduction, managers should understand the basic natural history of the species being introduced and conduct a thorough risk assessment (Simberloff et al. 2005). Wild turkeys can cause measurable depredation to agricultural crops, and provide a nuisance and damage personal property in urban environments (Miller et al. 2000, Spohr et al. 2004, Tefft et al. 2005, Gregonis et al. 2011). It is important to determine a tolerance level in areas of introduction so that the recreational and economic benefits outweigh the negative costs associated with a local flock (Miller et al. 2000). In order to measure tolerance, managers must have some knowledge of animal movements to help predict where released individuals may travel and appropriately set guidelines for consultations with landowners for pre-release assessments.

Although wild turkeys have long been established in Manitoba, their biology has never been studied in the province (Kimmel and Krueger 2007). This population persists at the northern extent of the current turkey range in North America, and although other studies have been conducted on established populations and translocations at northern latitudes (Roberts et al. 1995, Vander Haegen et al. 1998, Nguyen et al. 2003, Goetz et al. 2006, Kane et al. 2007), Manitoba's landscape and climate differs from these regions. The proposed collection of biological data from within Manitoba will contribute to management in the province; specifically in relation to managing and potentially expanding harvest structure, assessing the status of current populations and estimating trends, and planning future introductions.

In addition to domestic uses, data pertaining to turkey biology in Manitoba may also be of value when assessing proposed introductions in other jurisdictions. In recent decades, organizations in other Canadian provinces, including Nova Scotia (Neimanis and Leighton 2004) and New Brunswick (Balcomb 2005) have conducted assessments for proposed releases using data primarily derived from populations in southern Ontario and the northern United States. Data from Manitoba may also be of use to biologists in these and other Canadian provinces. In fact, the Saskatchewan Wildlife Federation is currently conducting a risk assessment regarding future introductions in that province, and pending the results and government approval, the federation and its affiliates may start releasing birds in the near future (Estevan Lifestyles 2014). As a part of the process, wildlife managers in Manitoba have already been approached regarding their experience managing turkey populations in the province, and the potential for acquiring birds from Manitoba for the proposed Saskatchewan introductions (Frank Baldwin, Manitoba Conservation and Water Stewardship, personal communication).

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CHAPTER 2 – SURVIVAL AND REPRODUCTION OF FEMALE EASTERN WILD TURKEYS IN THE PEMBINA VALLEY, MANITOBA

BACKGROUND

Survival

Minimal research has been conducted on wild turkeys within Manitoba; therefore when making management decisions, information on basic turkey biology has typically been extrapolated from other studies at northern latitudes. Many previous studies on northern turkey populations have focused on winter survival, assuming that winter conditions are a limiting factor in a population's survival. Goetz et al. (2006) found winter survival rates of only 39% and 32% in northwestern Minnesota for two experimental releases in areas with only natural food sources. Kane et al. (2007) also found low winter survival rates in central Minnesota, at 42.0% for turkeys introduced to an area where they relied on natural food sources, which differed from 78.6% survival in a population with access to supplemental food. An experimental release in the Precambrian Shield region of central Ontario found that winter survival was significantly lower during a severe winter, at 22%, compared to 90% when snow conditions were more favorable and food sources were abundant (Nguyen et al. 2003). Although snow conditions can limit access to natural foods, studies focused on established populations in New York (Roberts et al. 1995) and Massachusetts (Vander Haegen et al. 1988) found relatively high winter survival rates, even during severe temperature and/or snow depths, and concluded that winter conditions were not a limiting factor for turkey survival when they had access to food through agricultural practices.

Wild turkey populations in Manitoba typically overwinter at cattle feedlots and seed plants where they forage on spilt grain, livestock feed, and grains in manure piles (Gillespie

2003). At select wintering sites they are also provided grain via interceptor feeders set-up and managed by various wildlife groups to prevent depredation complaints (Frank Baldwin, Manitoba Conservation and Water Stewardship, personal communication). Anecdotal evidence from landowners suggests that winter mortality due to starvation, exposure, and disease within winter concentrations is relatively low.

In Manitoba it is thought that spring/summer survival rates may be more influential on population growth than winter survival. As with other species of ground-nesting birds like the mallard (*Anas platyrhynchos*) (Kirby and Cowardin 1986, Devries et al. 2003) and ruffed grouse (*Bonasa umbellus*) (Devers et al. 2007), female turkeys typically experience their lowest survival rates during the reproductive period, due to increased vulnerability while on nest (Vander Haegen et al. 1988, Palmer et al. 1993, Roberts et al. 1995). Ludwig (2012) and Roberts et al. (1995) both found that 61% and 46% of annual turkey mortality in Delaware and New York, respectively, occurred in during the reproductive period.

Mammalian and avian predation is typically the highest source of predation, however illegal and legal harvest, vehicle collisions, and disease have also been documented in studies monitoring radio-tagged wild turkeys (Vander Haegen et al. 1988, Vangilder and Kurzejeski 1995, Humberg et al. 2009). Similar to other jurisdictions across their northern range, the most common predators of turkeys in southern Manitoba are believed to be coyote, red fox, and great-horned owl (Kimmel and Kreuger 2007). The legal harvest of hens is not thought to be a major source of female mortality in Manitoba. Even though either sex can be harvested during the fall season (~37 hens harvested per year), and hens with a visible beard are legal during spring season, most hunters indicate that they selectively harvest males (Baldwin and Ryckman 2011). Outbreaks of avian pox (*Avipoxvirus* spp.) have been documented in Manitoba in the past, however outbreaks of diseases like this typically occur within winter concentrations of turkeys, therefore disease is not believed to have a major impact on spring/summer survival (Frank Baldwin, Manitoba Conservation and Water Stewardship, personal communication). This research investigates female eastern wild turkey survival and cause-specific mortality during the spring/summer reproductive period, an interval hypothesized to have the largest impact on annual survival in Manitoba's Pembina Valley sub-population.

Reproduction

Like other short-lived species, wild turkeys tend to allocate most of their resources towards reproduction in order to increase fecundity, due to the uncertainty of surviving to the next breeding season (Gill 2007, Townsend et al. 2008). Based on studies examining reproductive parameters in established populations at the northern extent of the turkey's ancestral range in southeastern Minnesota (Porter et al. 1983) and in southwestern Wisconsin (Paisley et al. 1998), it is possible for northern populations to have a 90.0-92.7% nesting frequency, 54.9-61.8% first nest success, a 41.3-65.0% renesting rate, an average clutch size of 10.3-11.7 eggs, and an 82.0% hatching success. Even during an experimental release in central Ontario, Nguyen et al. (2004) found a 58.8% nesting frequency, 50.0% nesting success, mean clutch sizes of 10 eggs, and an 81.0% hatching success during the first two nesting seasons after introduction. This widespread, low-cost reproductive effort occurring within a population results in the subsequent production having the largest influence on population growth rates, thus emphasizing the importance of monitoring reproduction in this species.

Fecundity, the total number of young raised successfully per individual, is influenced by nesting parameters like nesting frequency, nesting success, renesting rates, clutch size, and the survival of young (Gill 2007). As an extension of estimating fecundity within a population or group, some wild turkey studies have adopted the calculation of natality, the number of females hatched per female in the breeding population, as an effective means of summarizing productivity. In established, stable northern populations, Porter et al. (1983) in southeastern Minnesota and Vander Haegen et al. (1988) in Massachusetts both found natality rates of ~2.6 females hatched/female alive at breeding. Alternatively, Nguyen et al. (2003) found a lower natality rate of 1.18 in the two years immediately after an introduction in central Ontario. Thogmartin and Johnson (1999) found a very low natality rate of 0.4 in a declining population in Arkansas. This research measures female wild turkey reproductive effort and success, and production through natality; components that will be useful for understanding the current status of the population, and future modeling efforts.

STUDY AREA

The Pembina Valley is contained within the Manitou ecodistrict of the Aspen Parkland ecoregion in south-central Manitoba (Smith et al. 1998). The valley and the ecodistrict follow the Pembina River and its tributaries from the south-central Canada/U.S.A. border, northwest for approximately 120 kilometers (Figure 2.1). The Pembina Valley's landscape is characterized by generally a flat glacial till plain intersected by a wide glacial melt water channel with steep treed slopes typically ranging from 50 to 150 meters in length and a greater than 15 percent slope (Smith et al. 1998). The steepest slopes occur in the eastern portion of the valley where this study took place.

The Manitou ecodistrict is part of Manitoba's Grassland Transition Ecoclimatic Region which is defined by long, cold winters and short, warm summers (Smith et al. 1998). Average daily temperatures recorded in Snowflake, Manitoba from 1991-2007 ranged from -15.7° C in January to 18.8° C in July. Annual rainfall and snowfall averaged 426.5 mm and 138.3 cm, respectively during the same period (Environment Canada 2010a).

The region's soil structure consists mainly of Black Chernozemic soils deposited on shale, limestone and granite-based bedrock, and glacial till (Smith et al. 1998). The largest stands of contiguous forest cover exist within the Pembina River valley and its tributaries' ravines. The eastern portion of the valley contains forest stands and shrub land composed of mainly bur oak (*Quercus macrocarpa*), trembling aspen (*Populus tremuloides*), hazel (*Corylus* spp.), and saskatoon (*Amelanchier alnifolia*), interspersed with grassland patches containing tall prairie grasses and herbs (Smith et al. 1998). Cultivated fields dominate the glacial till plain, while varying in density along the valley floor. A large portion of the forest and grassland portions of the valley are used as pasture with cattle feedlots of varying size scattered across the landscape. Untilled land along the valley floor, and to a lesser extent on the glacial plain, is also commonly managed for native hay and forage crops such as alfalfa.

The region contains an established wild turkey population, which dates back to the province's initial introductions. This sub-population of turkeys was selected for this study based on its historical significance, higher-than average population levels, and historical harvest data indicating that a high proportion of the province's wild turkey harvest occurs within the region. Based on surveys conducted in 1999, 2004, 2009, and 2010, approximately 46% of the Manitoba's annual spring wild turkey harvest occurs within Game Hunting Area (GHA) 31 (Baldwin and Ryckman 2010, Baldwin and Ryckman 2011), which surrounds the eastern portion of the Pembina Valley and this entire study area.

Two wintering flocks were targeted during trapping and radio-tagging activities, which occurred at three farm sites during winter 2011 and winter 2012 (Figure 2.1). The study area, covering 40,752 ha, was defined by creating a minimum convex polygon (MCP) around all wild turkey locations collected during this study using ArcGIS 10.1 (Environmental Systems Research Institute, Redlands, California).

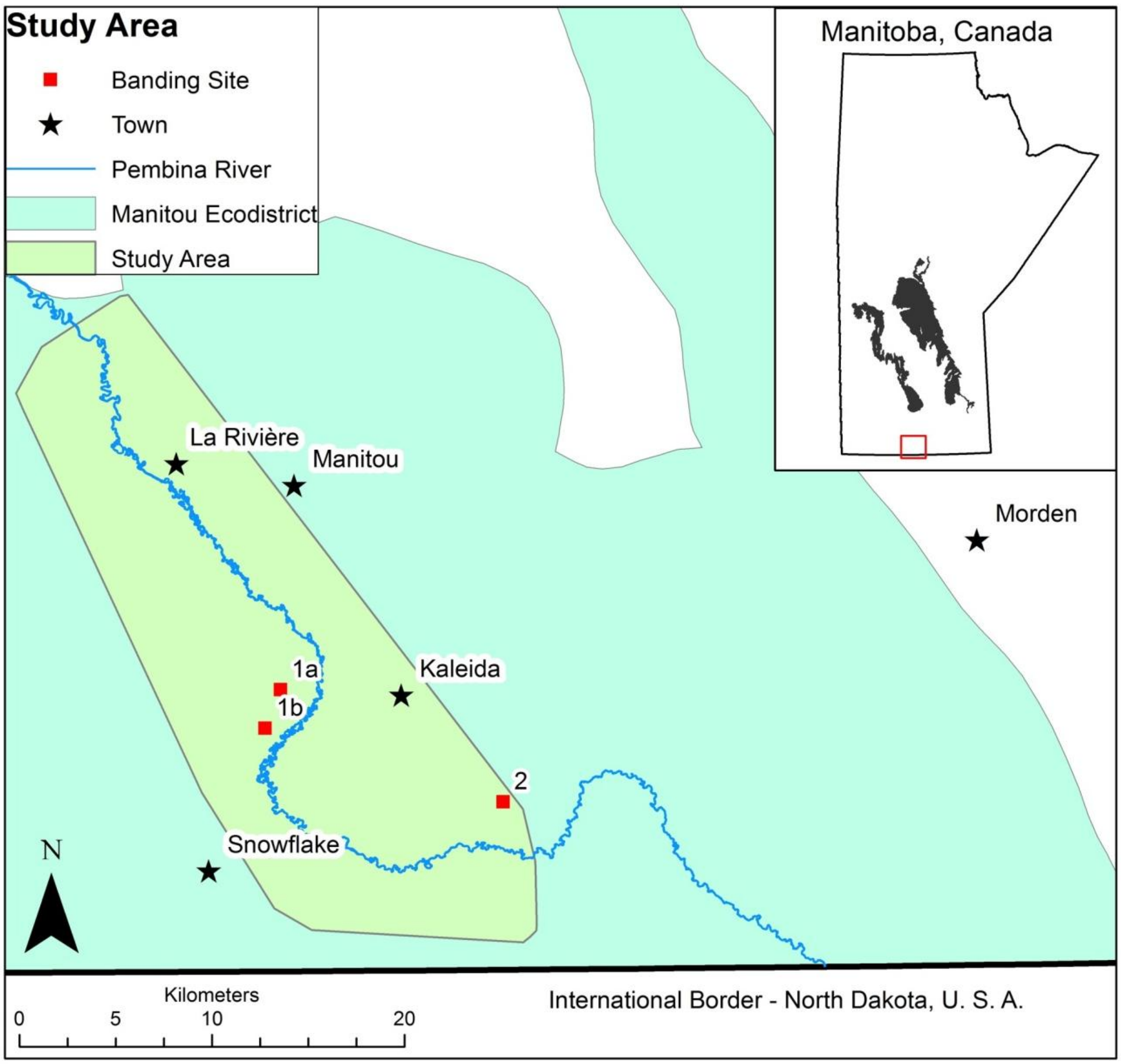

Figure 2.1: Study area (green shaded MCP as described in text) utilized by radio-marked female wild turkeys in the Pembina Valley region of southern Manitoba (see inset box for location within province, noting that major lakes are shown for reference).

METHODS

Capture and Monitoring

Standard operating procedures for all trapping activities associated with this study followed the guidelines set forth by Bailey et al. (1980). Wild turkeys were captured using a Martin Net-blaster (Wildlife Control Supplies, East Granby, Connecticut), firing a 40’ x 60’ net with 2” mesh designed for use with turkeys. Net-blasters were set-up at trapping sites in the weeks prior to trapping and were either strategically placed near interceptor feeders or agriculture bins where turkeys were known to feed. In addition to strategic placement, the area directly in front of the net was regularly baited with grain-screenings, cracked corn, and straw for scratching. When communication with landowners confirmed that the flocks were regularly feeding within a close proximity of the net-blaster, final preparations were made (net-blaster charged, net untangled, detonator attached, and bait replenished) for trapping to occur as individuals came out of their roosts shortly after dawn. The net-blaster was set off when an appropriate number of birds were within the net’s range.

Upon capture, turkeys were removed from the net and placed in wild turkey transfer boxes (National Wild Turkey Federation, Edgefield, South Carolina). Females were differentiated from males based on their brown tipped contour feathers. Individuals were then aged using the barring pattern and shape of the 9th and 10th primary feathers, and tail fan shape (Pelham and Dickson 1992). Beard length was recorded when a beard was present, and body weights were recorded during all but one trapping event. All hens captured were fitted with a size 8A aluminum rivet leg band (National Band and Tag, Newport, Kentucky) placed on the right metatarsal. Females that appeared in “good” (good body condition, no visible injuries or abnormalities, and minimal feather loss) or “fair” (good body condition, no visible injuries or abnormalities, and moderate feather loss on body) condition were fitted with an 80-gram, model A1540 backpack-style radio-transmitter (Advanced Telemetry Systems, Isanti, Minnesota). These transmitters sat on the bird's back with the antenna extending down the saddle resting on the tail coverts. Each transmitter was held in place using a single piece of nylon-coated shock-cord approximately 24 inches in length. This cord was passed through the transmitter, wrapped around each shoulder and passed back through the transmitter where the ends were tied off and sealed. In general, two fingers were placed between the bird's back and the transmitter during the fitting, ensuring that the transmitter was not loose enough to fall off or get caught on obstructions, but not so tight as to risk irritating the individual during potential body growth (Kenward 2001). For birds captured in 2012, the shock-cord was covered with shrink tubing where it met the transmitter to reduce abrasion. Individuals classified as in "poor" condition after capture (poor body condition, visible injuries, or significant wing and tail feather loss) were not radio-tagged. All individuals were released immediately after processing.

Spring monitoring commenced no less than 3-weeks after the last trapping date during both study years in order to censor any mortality events that may have been caused by capture related injury or myopathy. This censorship period exceeds that of many other wild turkey telemetry studies (Miller et al. 1995, Nguyen et al. 2003, Willsey 2003). Radio-marked hens were located throughout spring/summer (April 18 - September 1) for two consecutive years (2011 and 2012). Each hen was located 3 times per week, at varying times of day, typically once during each of the morning (sunrise - 10:00 am), afternoon (10:00 am - 4:00 pm), and evening (4:00 pm - sunset) time periods.

Each transmitter had 2 settings, active-mode (55 pulses per minute) and mortality-mode (110 pulses per minute), with the latter commencing after 8 hours of inactivity. To locate a radio-marked hen, I used direction-finding processes outlined by Samuel and Fuller (1994) and Chu et al. (1989) using either a vehicle mounted omnidirectional whip antenna or a handheld 3-element Yagi antenna and an ATS R2000 receiver (Advanced Telemetry Systems, Isanti, Minnesota). For individuals that were not visually observed, azimuths and collection locations were entered into LOCATE III (Pacer Computer Software, Tatamagouche, Nova Scotia) to derive a triangulated location. Broods associated with radio-marked hens were approached and flushed at least once during the final week of monitoring in each study year in order to estimate brood survival to September 1.

Nest Investigation

Following guidelines set by Paisley et al. (1998), a hen was considered incubating when 3 consecutive locations indicated localized behaviour, or further investigation of the individual revealed a nest or associated behaviour. Once a hen was presumed to be incubating or a nest was observed, a relative nest location was recorded and the individual's presence on the nest was further monitored. When incubating behaviour ceased, nests were located, and evidence of hatching or predation was documented, noting the number of eggs (both hatched and non-hatched) in successful nests, or the number of eggs or eggshell membranes in the vicinity of unsuccessful nests. The median date between the last observation of the hen on the nest and the date the hen was observed to have left the nest or was first suspected dead was recorded as the date of nest termination. A nest initiation date was calculated for successful nests by subtracting 28 days (26 for incubation and 2 for hatching) plus one additional day for each egg laid from the date of hatch (Paisley et al. 1998). Clutch sizes were occasionally collected opportunistically before incubation behaviour ceased, when periodic visits to the nest site revealed that the hen was away from the nest, but it had not been depredated and was still being incubated.

Mortality Investigation

When a transmitter was in mortality mode, the transmitter and/or carcass was located to determine if the mortality was caused by mammalian predation, avian predation, or another factor based on mortality descriptions outlined by Thogmartin and Schaeffer (2000). All predator sign observed in the immediate area of the depredation site was also recorded. The median date between the last observation of an active signal and the date that a mortality signal was observed was recorded as the date of mortality.

Analysis

This study used the Kaplan-Meier product limit estimator (Kaplan and Meier 1958) to determine wild turkey survival probabilities, based on its use in other wild turkey studies (Palmer et al. 1993, Miller et al. 1995, Roberts et al. 1995, Nguyen et al. 2003, Kane et al. 2007). This non-parametric approach is useful in radio-telemetry studies due to its ability to censor individuals that are lost due to transmitter and/or harness failure, or emigration out of the study area (Pollock et al.1989). Survival probability (S) and its associated variance is calculated as follows:

<u>Survival probability</u> = $S(t) = \prod (1\text{-}d_j/r_j)$

<u>Variance</u> = $\mathrm{var}[S(t)] = [S(t)]^2 \sum d_j \,/\, [1/r_j(r_j\text{-}d_j)]$

where:
- t = the spring/summer study period
- d = the number of deaths occurring at a certain time point (j) of a mortality event

- r = the number of individuals at risk at the same time point (j) of a mortality event

Since nesting activity took place throughout the entire study period in each year, a general spring/summer survival probability was estimated. The spring/summer monitoring period consisted of 136 days (April 18 - September 1) in 2011 and 133 days (April 18 - August 29) in 2012, and was broken into 20 monitoring weeks within each year that were used as time points in the survival analysis. Birds that survived a full year to reach the start of the next study period were considered ‘new’ individuals (Roberts et al. 1995). Following the approach of Palmer et al. (1993), given the small sample size in this study (especially with juveniles in 2011, n = 5), survival rates were compared between years using all individuals marked each year, and survival rates for adults and juveniles were compared by pooling years. Adults and juveniles were not compared within years. All hens lost during the monitoring period due to possible transmitter or harness failure, emigration out of the study area, or unreported legal or illegal harvesting were censored during the survival analysis.

Nest investigation data was used to calculate nesting frequency, renesting rate, nesting success (initial and renests), mean clutch size, hatching success, and mean brood size for both study years (Porter et al. 1983). Only hens that survived up to the earliest observed date of nest initiation for that study year were included in the nesting frequency analysis. Hen success was defined as the proportion of all marked hens that hatched at least 1 poult during that season (Roberts et al. 1995, Paisley et al. 1998). Brood survival was defined as at least 1 poult from a hatched brood surviving to September 1 in each study year. Based on Porter et al. (1983), reproductive parameters were summarized by natality rate (M_x), the number of females hatched per female alive at breeding, calculated as:

<u>Natality</u> = $M_x = (nf_x)(c_x)(ns_x)(hs_x)/2$

In which:
- nf_x = nesting frequency
- c_x = clutch size
- ns_x = nesting success
- hs_x = hatching success
- dividing by two assumes an equal sex ratio at hatching

Nesting success in the natality calculation was defined as the proportion of nesting hens that hatched at least 1 poult during the season (Vander Haegen et al. 1988). Age and year effects on nesting frequency, cumulative nesting success, first nest success and hen success were compared using a one-way analysis of variance (ANOVA). Age and year effects on renesting rates, success of 2nd and 3rd nests, clutch size, hatching success, brood size, and brood survival were not compared due to sample sizes ≤10 in all year and age groups. All statistical analyses were performed using SPSS 21 (IBM Corp., Armonk, New York). Significance was accepted as $P \leq 0.05$ during all age and year comparisons.

RESULTS

Capture

Twenty-three and twenty female wild turkeys were captured and radio-marked in the winters of 2011 and 2012, respectively (Appendix 1 & 2). No individuals were censored prior to monitoring in 2011; while 4 individuals were censored in 2012, due to mortality (n = 2), harness failure (n = 1), and unknown signal loss (n = 1) during the censorship period. Three turkeys survived through 2011 to the start of the 2012 study year and were incorporated into the analysis as new individuals in 2012.

Survival

Forty-one female wild turkeys were incorporated into the survival analysis. The cumulative female spring/summer survival probability (*S*) was 0.53 (95% CI = 0.37 - 0.68) (Table 2.1). Spring/summer survival probability did not differ ($P > 0.05$) between the 2011 (*S* = 0.41, 95% CI = 0.19 - 0.63) and 2012 (*S* = 0.67, 95% CI = 0.43 - 0.90) study years, or between adults (*S* = 0.424, 95% CI = 0.22 - 0.62) and juveniles (*S* = 0.714, 95% CI = 0.45 - 0.98). One individual was censored from the model after two weeks of monitoring in 2011 due to signal loss (Figures 2.2 & 2.3).

Table 2.1: Spring/summer (April 18 – September 1) survival probability (*S*) (including 95% confidence intervals) of radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during 2011 & 2012.

	n	***S***	**95% CI**
2011[a]	23	0.41	0.19 - 0.63
2012	18	0.67	0.43 - 0.90
Adult	27	0.42	0.22 - 0.62
Juvenile	14	0.71	0.45 - 0.98
Cumulative	**41**	**0.53**	**0.37 - 0.68**

[a] fate of one individual was unknown, and therefore censored after week 2 in the analysis.

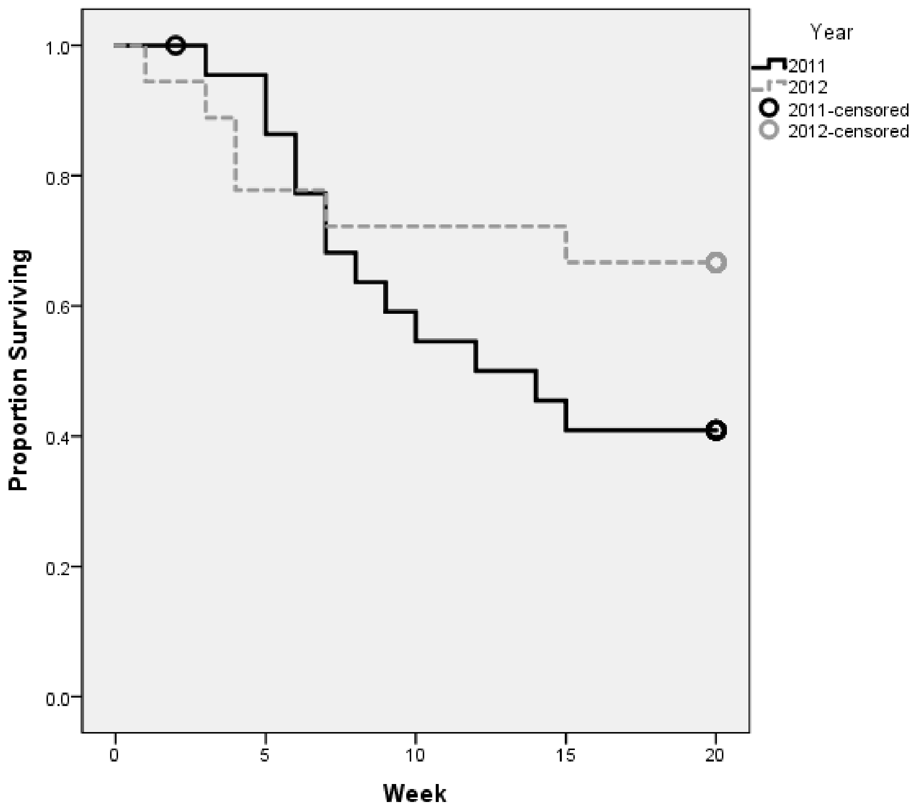

Figure 2.2: Spring/summer (April 18 – September 1) Kaplan-Meier survival curves, per study year, for radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during 2011 & 2012. Note: 1 individual was censored after week 2 in 2011.

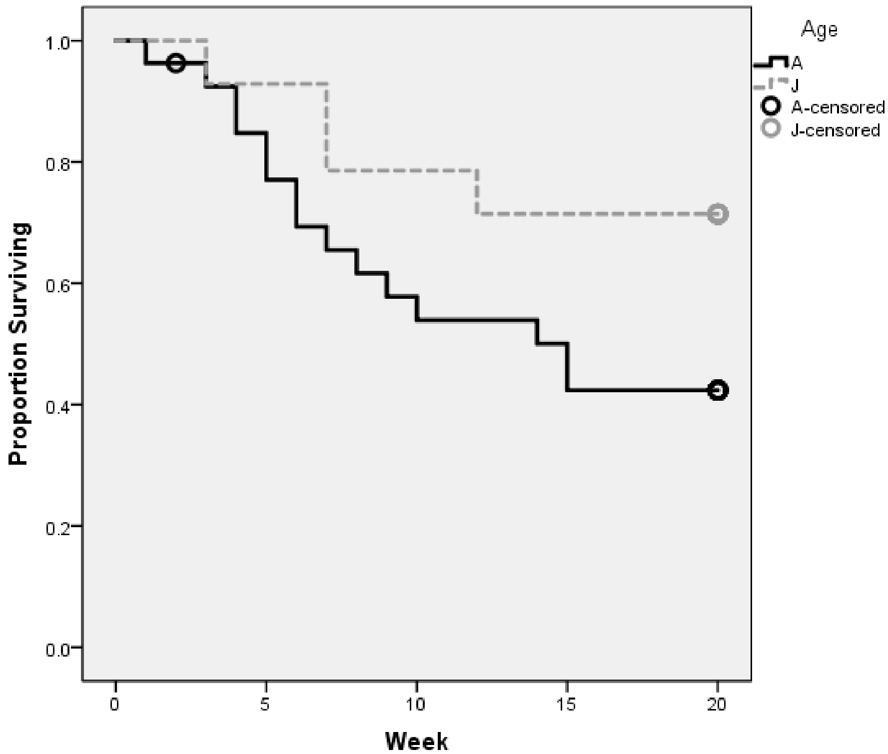

Figure 2.3: Spring/summer (April 18 – September 1) Kaplan-Meier survival curves, per age class (adults & juveniles), for radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during 2011 & 2012. Note: 1 adult was censored after week 2 in 2011.

Cause Specific Mortality

Mammalian predation accounted for 16 (84%) spring/summer mortality events. Avian predation, unknown predation, and dehydration (as determined by Manitoba Agriculture, Food and Rural Development's Veterinary Diagnostic Services Laboratory) each accounted for one (5%) mortality event. Over the study, 6 (32%) mortality events occurred when the female was either laying or incubating a nest, which was determined by signs of nesting activity observed during regular monitoring and the mortality investigation.

Reproduction

In total, 35 individuals were incorporated into the nesting frequency analysis, 40 individuals into the hen success analysis, and 48 nesting attempts into various nesting parameter analyses. One female abandoned its nest after being disturbed by the observer in 2012; therefore this nesting attempt was removed from all analyses, except for nesting frequency. The earliest date of nest initiation was calculated as April 30 in 2011 and April 3 in 2012.

Nesting frequency did not differ ($P > 0.05$) between years at 82% in 2011 and 100% in 2012, or between age classes at 91% in adults and 92% in juveniles (Table 2.2). Hen success, defined as the percentage of radio-marked hens that hatched at least one poult, regardless of the number of attempts, did not differ ($P > 0.05$) between 2011 (23%) and 2012 (50%), or between adults (26%) and juveniles (54%). Cumulative nesting success also did not differ ($P > 0.05$) between years at 29% in both 2011 and 2012, or between age classes at 23% in adults and 41% in juveniles. The renesting rate after first nest loss was 80% across all individuals and years. Third nests were only initiated in 2012, as only one individual in 2011 survived past its second nest failure to have the opportunity to nest for a third time, and did not initiate a third nest. The renesting rate after second nest loss in 2012 was 83%. All nest investigation and brood monitoring data was pooled to determine an average clutch size of 11.3 eggs/nest, 89% hatching success, an average brood size of 9.9 poults/brood, and an average brood survival rate (to September 1) of 36% over the course of the study (Table 2.3).

A natality rate of 2.3 females hatched per hen alive at breeding was calculated for the entire study period, with a higher rate of 2.8 being observed in juveniles than the rate of 1.7 observed in adults. Between years, the natality rate of 2.8 observed in 2012 doubled the rate of 1.4 observed in 2011 (Table 2.4).

Table 2.2: Estimates of nesting frequency (% that nested); first, second, third and cumulative nesting success (at least 1 egg hatched); first and second renest rates (initiated another nest after a failed attempt); and hen success (% that hatched at least 1 poult, regardless of the number of attempts) for radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.

		Nesting Frequency[a]		**First Nest Success**[b]		**First Renest Rate**[c]		**Second Nest Success**[b]		**Second Renest Rate**[c]		**Third Nest Success**[b]		**Cumulative Nesting Success**[d]		**Hen Success**[e]	
		%	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***
2011																	
	All	82	17	21	14	60	5	67	3	0	1	-	-	29	17	23	22
	Adult	85	13	18	11	75	4	67	3	0	1	-	-	29	14	24	17
	Juvenile	75	4	33	3	0	1	-	-	-	-	-	-	33	3	20	5
2012																	
	All	100	18	18	17	90	10	33	9	83	6	60	5	29	31	50	18
	Adult	100	9	0	9	100	5	40	5	100	3	33	3	18	17	30	10
	Juvenile	100	9	38	8	80	5	25	4	67	3	100	2	43	14	75	8
Pooled																	
	All	91	35	19	31	80	15	42	12	71	7	60	5	29	48	35	40
	Adult	91	22	10	20	89	9	50	8	75	4	33	3	23	31	26	27
	Juvenile	92	13	36	11	67	6	25	4	67	3	100	2	41	17	54	13

[a] percentage of hens that made at least 1 nesting attempt. Only hens that survived to the first recorded nesting attempt were included.
[b] at least 1 poult was hatched.
[c] only individuals that survived nest predation were included.
[d] fate of all first, second, and third nests combined.
[e] percentage of hens deployed that hatched at least 1 poult, regardless of the number of attempts (Roberts et al. 1995, Paisley et al. 1998).

Table 2.3: Estimates of clutch size (number of eggs), hatching success (proportion of eggs hatched in successful nests), brood size (number of poults per brood) and brood survival (% of broods that survived to September 1) for radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.

		Clutch Size			Hatching Success			Brood Size			Brood Survival[a]	
		x	**SD**	***n*[b]**	***x***	**SD**	***n*[b]**	***x***	**SD**	***n*[b]**	**%**	***n*[b]**
2011												
	All	11.0	1.5	7	0.87	0.17	5	9.2	1.6	5	20	5
	Adult	10.8	1.6	6	0.93	0.15	4	9.5	1.7	4	25	4
	Juvenile	12.0	-	1	0.67	-	1	8.0	-	1	0	1
2012												
	All	11.4	1.1	9	0.91	0.90	7	10.4	1.8	7	44	9
	Adult	11.8	1.5	4	1.00	0.00	2	12.0	1.4	2	67	3
	Juvenile	11.2	0.8	5	0.87	0.80	5	9.8	1.3	5	33	6
Pooled												
	All	11.3	1.3	16	0.89	0.13	12	9.9	1.7	12	36	14
	Adult	11.2	1.5	10	0.95	0.12	6	10.3	2.0	6	43	7
	Juvenile	11.3	0.8	6	0.84	0.11	6	9.5	1.4	6	29	7

[a] at least 1 poult from brood survived to September 1.
[b] sample sizes not the same for all parameters due to some nest were either not found or disturbed before investigation, therefore a reliable estimate of hatched/unhatched eggs was not available.

Table 2.4: Natality rates (females hatched per female alive at breeding) calculated using estimates of nesting frequency (proportion of females that nested), clutch size (number of eggs), nesting success (proportion of females that successfully hatched a clutch), and hatching success (proportion of eggs hatched in successful nests), for radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.

		Nesting Frequency	Clutch Size	Nesting Success[a]	Hatching Success	Natality Rate[b]
2011						
	All	0.82	11.0	0.36	0.87	**1.4**
	Adult	0.85	10.8	0.36	0.93	**1.5**
	Juvenile	0.75	12.0	0.33	0.67	**1.0**
2012						
	All	1.00	11.4	0.53	0.91	**2.8**
	Adult	1.00	11.8	0.33	1.00	**2.0**
	Juvenile	1.00	11.2	0.75	0.87	**3.7**
Pooled						
	All	0.91	11.3	0.50	0.89	**2.3**
	Adult	0.91	11.2	0.35	0.95	**1.7**
	Juvenile	0.92	11.3	0.64	0.84	**2.8**

[a] percentage of nesting hens that hatched at least 1 poult, regardless of the number of nesting attempts (Vander Haegen et al. 1988).
[b] females hatched/females alive at breeding

DISCUSSION

Cumulative spring/summer survival probability in this study at 53%, was lower than rates found in other established northern populations, which range between 60-78% (Treiterer 1987, Vander Haegen et al. 1998, Roberts et al. 1995, Spohr et al. 2001), however the 95% confidence interval (37-68%) observed is within this range, and “spring/summer” or “reproductive period” dates do vary slightly throughout the literature. Adult spring/summer survival probability (42%) across this study was 29% lower than juvenile survival (71%), which differs from most other studies that have found equal, or higher survival rates in adult females (Vander Haegen 1988, Roberts et al. 1995, Keegan 1996, Spohr 2001, Holder 2006, Reynolds and Swanson 2011). Even though survival in these two cohorts differed by 29%, the difference is not considered significant ($P > 0.05$) and their 95% confidence intervals overlap.

Mammalian predation was the major source of mortality observed in this study (84%), and the influence of unusually high coyote populations could explain the relatively low cumulative spring/summer survival rate and the 26% increase in survival observed between 2011 and 2012. A lack of quantifiable data does not permit a population estimate for coyotes in the study area, however landowner reports indicate that populations have become more abundant in recent years. This observation is supported by a peak of 29 coyote-livestock depredation claims filed in the Rural Municipality (RM) of Pembina during 2011; well above the 12-year mean of 10.5 (Manitoba Agricultural Services Corporation, unpublished data). A 17-year peak of 1.6 coyote pelts sold/open area trapping license sold in southern Manitoba also occurred during the 2011/12 trapping season, indicating that coyote populations were relatively high province-wide (Manitoba Conservation and Water Stewardship, unpublished data). The occurrence of both these peaks during and immediately after the 2011 study year may explain why a low spring/summer survival probability of 41% was observed that year. Both the number of depredation claims in the RM of Pembina (11) and coyote pelts sold/open area trapping license (1.4) declined during or immediately after the 2012 study year, when female wild turkey spring/summer survival increased to 67%.

The severity of winter weather in the months prior to the spring/summer season differed greatly between study years and may have caused females wild turkeys to enter the reproductive period in poorer body condition in 2011 than in 2012, accounting for the 26% variation in survival between years. Ludwig (2012) observed similar differences in survival between years (~21% difference in annual survival) in Delaware and hypothesized that heavy snowfall during one winter may have caused females to enter the nesting season in poorer body condition making them more susceptible to predation. The Porter et al. (1983) study in southeastern Minnesota supports this by finding that females with lower body weights in late winter were less likely to survive to June 1 than heavier females. In this study, the winter of 2011 can be classed as 'non-favorable' due to 'cold' temperatures and a long snow cover period, while 2012 was 'favorable' with 'mild' temperatures and minimal snow cover. Mean monthly temperatures recorded in Morden, Manitoba (~30 km from the study area) for February, March and April 2011 were -12.0º C, -7.2º C and 4.4º C, respectively, compared to -6.5º C, 2.4º C, 6.7º C in February, March and April 2012, respectively (Environment Canada 2010b). These weather records also indicate that Morden, Manitoba had 142 days of snow cover during the winter prior to the 2011 spring/summer period, while the winter prior to the 2012 study period recorded only 13 days of snow cover.

The longer snow cover period and a later start to the growing season observed in 2011 may have resulted in lower levels of vegetative concealment, which is important during nest site selection (Holbrook et al. 1987, Badyaev et al. 1996), making hens more vulnerable to predation while on nest during that study year, lowering the observed survival probability. A possible difference in vegetative concealment between years appears supported by twice as many radio-marked hens preyed upon while nesting in 2011 (n = 4) than in 2012 (n = 2), with two additional individuals attacked while on nest, but escaping predation in 2011. Differences in vulnerability and survival between years aside, similar to Miller et al. (1995), the greatest decline in survival probability in both study years coincided with the weeks that most hens were initiating their first nests (weeks 5-7 in 2011 and weeks 1-4 in 2012).

March weather appears to have had an effect on the commencement of the nesting season during the course of this study, resulting in a 27-day difference in the earliest date of nest initiation between study years. The earliest observed date of nest initiation was April 30 in 2011, versus April 3 in 2012. Furthermore, 5 radio-marked hens were observed nesting by the start of monitoring (April 18) in 2012, compared to no individuals in 2011. Vanguilder and Kurzejeski (1995) noticed a similar variation in northern Missouri, where the median date of first nest initiation varied by 28 days across a 7-year study. They also found a "nearly significant" correlation between nest initiation dates and the number of days in March where the maximum temperature was below 0º C. In this study, March 2011 had 17 days where the maximum temperature was <0º C, compared to March 2012, which had 9 days where the maximum temperature was <0º C (Environment Canada 2010b). The higher number of days where the maximum temperature was <0º C, along with differences in mean daily temperature and snow cover, undoubtedly delayed the growing season 2011, and likely breeding activity, as well (Healy 1992).

The existence of a richer and more abundant nest predator community existing in this study area would help explain why first nesting success (19%) and cumulative nesting success (29%) were lower than the typical nesting success range (36-62%) found in other northern wild turkey studies (Porter et al. 1983, Vander Haegen et al. 1988, Roberts et al. 1995, Sphor 2001). A few species that are believed to exist at relatively high numbers throughout southern Manitoba were known to depredate nests during this study, based on tracks and eggshell breakage patterns observed opportunistically at depredated nest sites (Henandez et al. 1997). The raccoon (*Procyon lotor*) has experienced a notable expansion in range and abundance across the Canadian Prairies since the 1990's, presumably due to an increase in food availability (Lariviere 2004). Stripped skunk (*Mephitis mephitis*) are also thought to be abundant, which may be related to their preference for selecting abandoned farm buildings as den sites (Lariviere and Messier 1998); habitat that is likely increasing with current trends in farm abandonment, shown by a 16.8% decrease in the number of commercial farms in Manitoba between 2006 and 2011 censuses (Statistics Canada 2014). Although this is the first study investigating wild turkey nesting success in this region, nesting success for mallards, which commonly nest in upland habitats, has been studied extensively across the Prairie Pothole Region of North Dakota and Southern Manitoba, revealing relatively low rates of 5-13% (Klett et al. 1988, Arnold et al. 1993, Greenwood et al. 1995). While no comparative data exists between northern wild turkey jurisdictions, one hypothesis would be that nest predation pressure in Manitoba exceeds that of other areas.

The pooled hen success (35%) determined in this study lies within the range found in other northern wild turkeys studies. Using the same format for calculating hen success, Paisley et al. (1998) found a lower hen success rate (21.7%) in Wisconsin, while Roberts et al. (1995) found higher hen success rates in adults (51.1%) in New York, but lower rates in juveniles (28.8%). Hen success in this study was higher in juveniles (54%) than adults (26%), but the difference was not statistically significant.

March temperature and snow cover, which effects the growing season, nesting activities, and survival, likely explains the 27% (non-significant) difference in hen success observed between 2011 and 2012. Vanguilder and Kurzejeski (1995) suggested that extreme March temperatures in northern Missouri might lower hen success by notably delaying growing season, which limits a hen’s ability to initiate and successfully hatch a clutch due to low levels of nest concealment and foraging opportunity during early spring. This theory, supported by the disparity between mean March temperatures in 2011 (-7.2º C) and 2012 (2.4º C) (Environment Canada 2010b), could explain why hen success was higher in 2012 (50%) than in 2011 (23%). Higher survival through the nesting period in 2012 enabled 5 of 6 radio-marked hens that survived past 2 failed nesting attempts to initiate third nests; 3 of which were successful, accounting for 33% of that year's successful hens. Lower survival through the nesting period in 2011 resulted in only 1 hen surviving past 2 failed nesting attempts.

Wild turkey nesting frequency, clutch size, and hatching success figures presented in this study are within the ranges documented in other northern studies at 81-93%, 10-14.8 eggs, and 72-90%, respectively (Green 1982, Porter et al. 1983, Vander Haegen et al. 1988, Roberts et al. 1995, Paisley et al. 1998, Sphor 2001). Renesting rates in this study, 80% for first renest and 71% for second renest, were higher than in most northern regions, which range from 18-65% (Porter et al. 1983, Vander Haegen et al. 1988, Paisley et al. 1998, Sphor 2001).

The natality rate, the number of females hatched per hen in the breeding population, observed across this study (2.3) was more similar to stable/increasing wild turkey populations than decreasing and recently introduced populations, suggesting that production in this study area is consistent with that of a healthy population. Vander Haegen et al. (1988) calculated a natality rate of 2.57 in a Massachusetts population that was believed to be "relatively stable", based on densities of wintering birds during the study. Furthermore, in southern Minnesota, Porter et al. (1983) found natality rates of 2.6 and 2.1 during first and second nesting attempts, respectively, in a population considered to be "undergoing rapid growth" during the study due to the results of gobbling count surveys conducted during the same period (Porter and Ludwig 1980). Conversely, Nguyen et al. (2003) found a natality rate of 1.18 during the first two years after introducing a population in central Ontario, and Thogmartin and Johnson (1999) found a rate of 0.42 in an Arkansas population that was presumably declining, based on a 50% decrease in harvest.

Of some concern would be the relatively low natality rate that followed the 'non-favorable' winter of 2011, which coupled with low brood survival, suggests that recruitment was low that year, as well. The natality rate of 1.4 was slightly above the replacement level of 1.0, and brood survival (at least 1 poult from the brood survived to September 1) was estimated to be 20%. Based on these two figures, it can be hypothesized that recruitment of females into the adult population was below replacement levels during that year.

MANAGEMENT IMPLICATIONS

This study acquired baseline female survival and reproduction data that can be used to model wild turkey populations in the province by gauging the health of current sub-populations and predicting the impact of future management actions and environmental conditions. Before this study the only way that managers in Manitoba could assess population trends was to use hunter questionnaires that estimate harvest (~93% males) and collect hunter's opinions on whether turkey numbers changed from the previous year in the GHA where they hunted (e.g. 'increased', 'decreased', or 'same') (Baldwin and Ryckman 2011). Although hunter opinion data is useful when gauging hunting quality (Dingman et al. 2007), and changes in harvest rates can identify population declines (typically for males which may have different limiting factors) (Lint et al. 1995, Thogmartin and Johnson 1999), defining female survival rates, cause-specific mortality, hen success and production, along with their variation over time, is necessary when managing wild turkey populations (Vanguilder and Kurzejeski 1995). This study was able to provide examples of these parameters during reproductive seasons following 'favorable' and ‘non-favorable’ winters. Pairing these results with additional survival and harvest rate data collected through banding and camera trap studies conducted during the same study period will allow managers to construct population models and assess the potential impact of observed weather conditions and varying levels of harvest, without having to extrapolate figures from other northern wild turkey studies.

Analyzing natality outside of a population model suggests that the Pembina Valley sub-population is fairly ‘stable’ based on the cumulative natality rate, however the natality rate of 1.4 and 20% brood survival observed after the ‘non-favorable’ winter of 2011 suggests that recruitment that year was below replacement levels, and successive years with relatively low survival and production could result in population declines. Since wild turkeys tend to concentrate at farm sites and urban areas during the winter, managers should continue to ensure that landowners are willing to tolerate turkeys foraging around these sites. If this tolerance level is exceeded, managers should approach the various wildlife groups that conduct interceptor feeding within province, and encourage them to deploy additional feeders where necessary, especially during ‘non-favorable’ winters when turkeys require access non-traditional food sources more often, due to increased snow conditions and colder weather. Appropriate management plans and action should reduce the potential for mass declines in survival and production across the province, and also reduce human-turkey conflicts.

Based on hunter questionnaire data identifying that a high proportion of wild turkey hunters are selective during the spring hunting season, the legal harvest of hens was not suspected to be a major source of spring/summer mortality, however the disappearance of 1 radio-marked individual during the 2011 hunting season in this study does show that it may remain a minor factor. It is possible that this individual, who did not have a ‘visible beard’ during capture, may have been harvested illegally or by a rights-based resource user, both aspects of harvest that are difficult to quantify. Since the individual was never recovered, it may have also experienced transmitter failure or emigration from the study area. If Manitoba Conservation and Water Stewardship wishes to increase hunting opportunity and offer an additional (second) resident wild turkey license, consideration should be given to the potential impacts of legal and illegal hen harvest, even though it appears to be low. Multiple options for implementing a second licence should be explored, including spring-only use, alternative season dates, and restrictions for use only in certain Game Hunting Areas.

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CHAPTER 3 – FEMALE EASTERN WILD TURKEY MOVEMENT AND HABITAT USE IN THE PEMBINA VALLEY, MANITOBA

BACKGROUND

Dispersal

Dispersal is a strategy used by most mammal and birds species to reduce competition for both resources and reproductive opportunity; and serves to augment the genetic structure of a given population (Greenwood 1980, Waser 1985). Since natal groups of wild turkeys do not separate until after their first fall/winter, and at northern latitudes wild turkeys tend to concentrate at discrete food sources, the distance that they travel from a wintering site to their breeding and nesting areas each spring is termed “spring dispersal”. Gaining an understanding of spring dispersal distances is important when introducing birds to new areas, as managers should assess the probability of introduced birds establishing multiple wintering flocks, and maintaining effective gene flow within the sub-population once established (Leberg et al. 1994). The timing of spring dispersal is also important to consider when setting hunting season dates, to ensure that flocks have moved away from wintering sites and are occupying spring ranges before the hunting season commences (Baldwin and Ryckman 2011).

Generally, juvenile wild turkeys of both sexes disperse farther from wintering sites than adults (Porter 1977, Hayden et al. 1980, Hoffman 1991, Keegan 1996). In other established northern populations, Vander Haegen et al. (1988) documented that female turkey dispersal in Massachusetts ranged from 0-14.8 km, while Hayden et al. (1990) calculated mean dispersal distances in Pennsylvania to be 3.2 km and 7.4 km for adult and juvenile hens, respectively, with a maximum movement of 24 km. Carroll and Thompson (1986) found that turkeys translocated to eastern Kentucky did not disperse far from wintering sites during the first spring after release with distances ranging from 0.95-1.75 km; as did Little and Varland (1981) in central Iowa where females on average only dispersed 1.9 km during their first spring. Little and Varland (1981) did however notice a gradual increase in dispersal during the second and third years after introduction, with average dispersal distances increasing to 3.0 km and 4.9 km, respectively.

Although dispersal distances from both wintering sites and introduction sites are well documented in the literature, it is likely that other distances do not accurately represent those of established populations or introductions in Manitoba since habitat availability (Carroll and Thompson 1986), population density, competition (Badyaev et al. 1996), predator avoidance (Shields and Flake 2004), and natural and anthropogenic movement corridors (Gustafson and Gardner 1996) can influence dispersal. The effect of these factors may vary when compared between Manitoba and other regions. I estimated timing and distances associated with spring dispersal for female wild turkeys in Manitoba's Pembina Valley sub-population, to better understand how turkeys are distributed across a landscape when spring hunting seasons open, and what distances turkeys could potentially move post-introduction.

Home Range

The home range of any species can be defined as the area in which an animal resides over time, that provides it with sufficient food sources, levels of shelter, escape cover, and competition avoidance during its daily activities (Smith and Smith 2003). Much like dispersal, both home range selection and size are affected by habitat availability, population density, competition, predator avoidance, and the presence/absence of movement corridors (Carroll and Thompson 1986, Badyaev et al. 1996, Gustafson and Gardner 1996, Shields and Flake 2004). Since home range size is influenced by many different factors, female eastern wild turkey home range sizes vary across their North American range. Annual mean home range sizes as large as 3514 ha have been documented in the Ouachita Mountains of Arkansas (Wigley et al. 1986), while much smaller annual home range sizes of 552 ha were recorded in Central Missouri (Ellis and Lewis 1967). Differences in annual home range have also been observed within the same study area based on the type of habitat being occupied by the individual. Females in northern Pennsylvania occupying forest habitats were found to have annual home ranges that were more than twice the size of individuals inhabiting dairy-woodlot habitats, at 1227 ha and 532 ha in size, respectively (Hayden et al. 1980).

Eastern wild turkey seasonal home ranges also vary across North America. Females in southeastern Oklahoma were found to have spring and summer home ranges of 865 and 780 ha, respectively (Bidwell et al. 1989), compared to females in northern Missouri that had smaller spring and summer home ranges, averaging 100.8 and 174.7 ha, respectively (Kurzejeski and Lewis 1990).

In general, juvenile wild turkeys of both sexes show greater levels of movement as they are searching for territories (breeding in males or nesting in females) that are not occupied by dominant individuals (Badyaev et al. 1996), therefore juveniles can have home ranges that are twice the size of adults (Hoffman 1991, Keegan 1996, Thogmartin 2001). I estimate average spring/summer home range sizes for adult and juvenile female eastern wild turkeys in Manitoba's Pembina Valley, to better understand movement by hens during the reproductive period, and assess habitat selection based on individual home ranges.

Habitat Use

Across North America, eastern wild turkey populations reside in a wide variety of ecosystems, including managed pine landscapes in the central and southern United States (Bidwell et al. 1989, Miller and Conner 2007); hardwood dominated forests of the eastern United States and eastern Canada (Wilson and Lewis 1959, Rinkes 2004); prairie-woodland environments in the central United States (Cully et al. 1999, Shields and Flake 2004); and mixed wood forests of the Precambrian Shield in central Ontario (Nguyen et al. 2004). Once believed to require large contiguous parcels of mature mast-producing forests, eastern wild turkeys have shown that they can adapt to a wide variety of habitats (Porter 2007), likely in part to the landscape of eastern North American becoming dominated by agriculture, providing turkeys with easily accessible year-round food sources (Kimmel and Kruger 2007). Their only universal land cover requirements seem to be access to trees that provide food, escape cover, and roosting opportunities; and sufficient grass cover that provides both nesting cover and a source of insects, which are important in the development of poults (Porter 1992). Eastern wild turkeys rarely inhabit marsh environments (due to their reliance on ground-based travel) and dry-areas with inhibited tree growth and a low level of access to water resources (Porter 1992).

Many studies have shown that wild turkeys utilize fragmented habitats, rather than the traditional belief that they preferred only large sections of undisturbed habitat. Swanson et al. (2004) and Thogmartin (1999) both found that turkeys nested closer than expected to roads and other edge features. In addition to nesting near edges, various studies have documented nesting in a wide variety of land cover types, even within one particular region (Keegan 1996, Nguyen et al. 2004, Shields and Flake 2004). Even though they can nest in variety of habitats, turkeys can favor some cover types over others. Preference that may even shift with the growing season, as observed by Day et al. (1991), where turkeys in South Dakota selected woodlands early in the nesting period, and grasslands after May 1. Grassland, forage crops, cultivated fields, and old-field habitats are typically preferred during the brood rearing period (Porter 1980, Kurzejeski and Lewis 1990, Swanson et al. 2004). Porter (1980) also found that wild turkey broods in southeastern Minnesota preferred ranges with medium levels of interspersion, or ~17 habitat patches per square kilometer.

In all geographic regions, wild turkeys routinely form flocks starting in the late fall, eventually residing at the same wintering areas, year after year (Healy 1992). Since the northern extent of the turkey's ancestral range was dictated by snow depths, the success of range expansion efforts has relied upon access to non-traditional food sources during periods of deep snow, making beef, dairy, and other agricultural production sites important features in habitats occupied by northern populations (Vander Haegen et al. 1989, Parent et al. 2007).

Based on the importance of woodlands, grasslands, and agriculture, both Kurzejeski and Lewis (1990) and Brenner and Brown (1990) concluded that turkeys selected annual ranges with a 1:1 ratio of woodlands to open/crop lands in northern Missouri and Pennsylvania, respectively. This research determines female eastern wild turkey habitat selection in Pembina Valley sub-population on a study area scale and within individual home ranges, which when paired with dispersal information, will guide future introductions and qualify unoccupied areas of Manitoba as potential habitat.

STUDY AREA

The Pembina Valley is contained within the Manitou ecodistrict of the Aspen Parkland ecoregion in south-central Manitoba (Smith et al. 1998). The valley and the ecodistrict follow the

Pembina River and its tributaries from the south-central Canada/U.S.A. border, northwest for approximately 120 kilometers (Figure 3.1). The Pembina Valley's landscape is characterized by generally a flat glacial till plain intersected by a wide glacial melt water channel with steep treed slopes typically ranging from 50 to 150 meters in length and a greater than 15 percent slope (Smith et al. 1998). The steepest slopes occur in the eastern portion of the valley where this study took place.

The Manitou ecodistrict is part of Manitoba's Grassland Transition Ecoclimatic Region which is defined by long, cold winters and short, warm summers (Smith et al. 1998). Average daily temperatures recorded in Snowflake, Manitoba from 1991-2007 ranged from -15.7° C in January to 18.8° C in July. Annual rainfall and snowfall averaged 426.5 mm and 138.3 cm, respectively during the same period (Environment Canada 2010a).

The region's soil structure consists mainly of Black Chernozemic soils deposited on shale, limestone and granite-based bedrock, and glacial till (Smith et al. 1998). The largest stands of contiguous forest cover exist within the Pembina River valley and its tributaries' ravines. The eastern portion of the valley contains forest stands and shrub land composed of mainly bur oak (*Quercus macrocarpa*), trembling aspen (*Populus tremuloides*), hazel (*Corylus* spp.), and saskatoon (*Amelanchier alnifolia*), interspersed with grassland patches containing tall prairie grasses and herbs (Smith et al. 1998). Cultivated fields dominate the glacial till plain, while varying in density along the valley floor. A large portion of the forest and grassland portions of the valley are used as pasture with cattle feedlots of varying size scattered across the landscape. Untilled land along the valley floor, and to a lesser extent on the glacial plain, is also commonly managed for native hay and forage crops such as alfalfa.

The region contains an established wild turkey population, which dates back to the province's initial introductions. This sub-population of turkeys was selected for this study based on its historical significance, higher-than average population levels, and historical harvest data indicating that a high proportion of the province's wild turkey harvest occurs within the region. Based on surveys conducted in 1999, 2004, 2009, and 2010, approximately 46% of the Manitoba's annual spring wild turkey harvest occurs within Game Hunting Area (GHA) 31 (Baldwin and Ryckman 2010, Baldwin and Ryckman 2011), which surrounds the eastern portion of the Pembina Valley and this entire study area.

Two wintering flocks were targeted during trapping and radio-tagging activities, which occurred at three farm sites during winter 2011 and winter 2012 (Figure 2.1). The study area, covering 40,752 ha, was defined by creating a minimum convex polygon (MCP) around all wild turkey locations collected during this study using ArcGIS 10.1 (Environmental Systems Research Institute, Redlands, California).

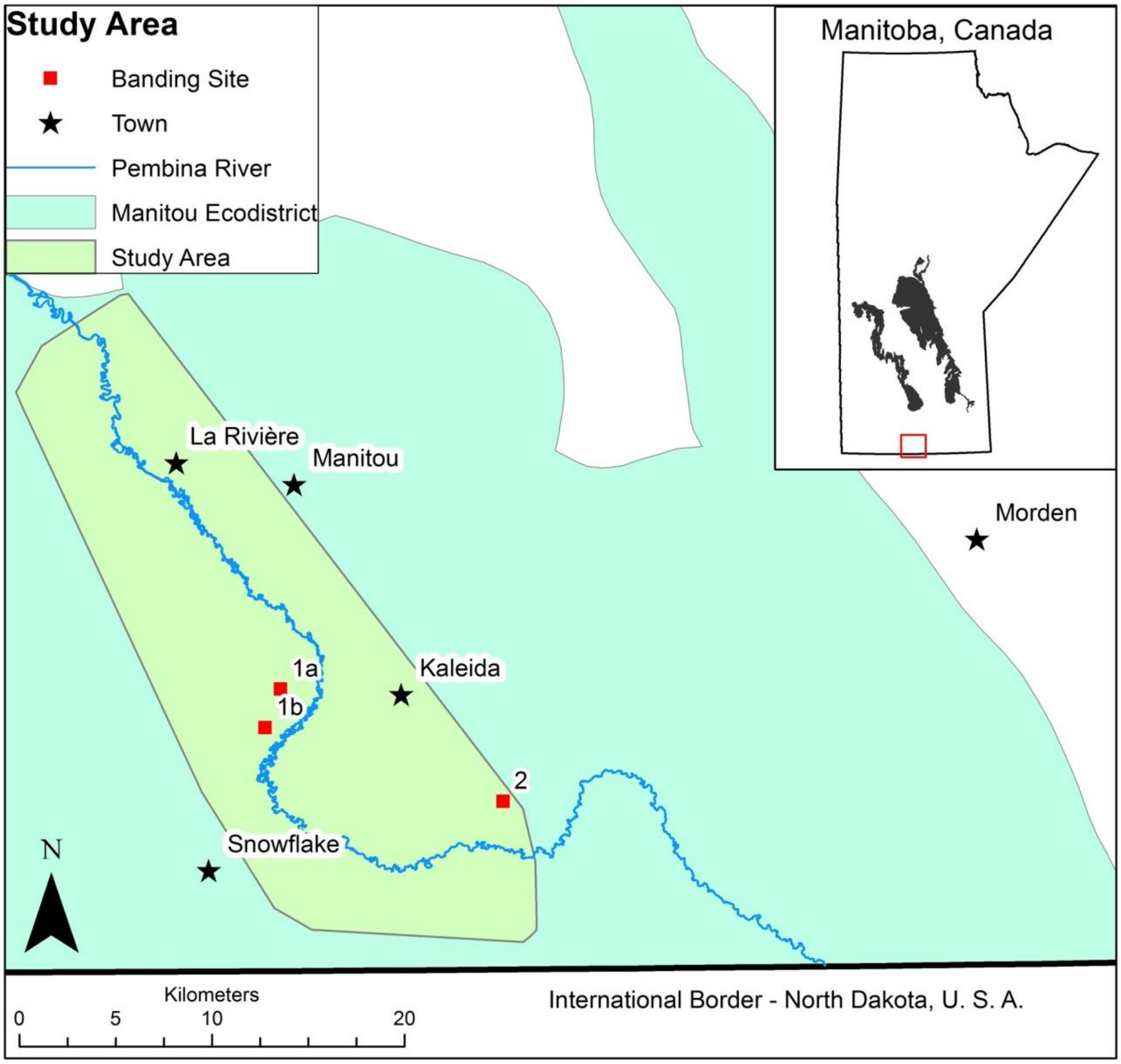

Figure 3.1: Study area (green shaded MCP as described in text) utilized by radio-marked female wild turkeys in the Pembina Valley region of southern Manitoba (see inset box for location within province, noting that major lakes are shown for reference).

METHODS

Capture and Monitoring

Standard operating procedures for all trapping activities associated with this study followed the guidelines set forth by Bailey et al. (1980). Wild turkeys were captured using a Martin Net-blaster (Wildlife Control Supplies, East Granby, Connecticut), firing a 40’ x 60’ net with 2” mesh designed for use with turkeys. Net-blasters were set-up at trapping sites in the weeks prior to trapping and were either strategically placed near interceptor feeders or agriculture bins where turkeys were known to feed. In addition to strategic placement, the area directly in front of the net was regularly baited with grain-screenings, cracked corn, and straw for scratching. When communication with landowners confirmed that the flocks were regularly feeding within a close proximity of the net-blaster, final preparations were made (net-blaster charged, net untangled, detonator attached, and bait replenished) for trapping to occur as individuals came out of their roosts shortly after dawn. The net-blaster was set off when an appropriate number of birds were within the net’s range.

Upon capture, turkeys were removed from the net and placed in wild turkey transfer boxes (National Wild Turkey Federation, Edgefield, South Carolina). Females were differentiated from males based on their brown tipped contour feathers. Individuals were then aged using the barring pattern and shape of the 9^{th} and 10^{th} primary feathers, and tail fan shape (Pelham and Dickson 1992). Beard length was recorded when a beard was present, and body weights were recorded during all but one trapping event. All hens captured were fitted with a size 8A aluminum rivet leg band (National Band and Tag, Newport, Kentucky) placed on the right metatarsal. Females that appeared in “good” (good body condition, no visible injuries or abnormalities, and minimal feather loss) or “fair” (good body condition, no visible injuries or abnormalities, and moderate feather loss on body) condition were fitted with an 80-gram, model A1540 backpack-style radio-transmitter (Advanced Telemetry Systems, Isanti, Minnesota). These transmitters sat on the bird’s back with the antenna extending down the saddle resting on the tail coverts. Each transmitter was held in place using a single piece of nylon-coated shock-cord approximately 24 inches in length. This cord was passed through the transmitter, wrapped around each shoulder and passed back through the transmitter where the ends were tied off and sealed. In general, two fingers were placed between the bird's back and the transmitter during the fitting, ensuring that the transmitter was not loose enough to fall off or get caught on obstructions, but not so tight as to risk irritating the individual during potential body growth (Kenward 2001). For birds captured in 2012, the shock-cord was covered with shrink tubing where it met the transmitter to reduce abrasion. Individuals classified as in "poor" condition after capture (poor body condition, visible injuries, or significant wing and tail feather loss) were not radio-tagged. All individuals were released immediately after processing.

Spring monitoring commenced no less than 3-weeks after the last trapping date during both study years in order to censor any mortality events that may have been caused by capture related injury or myopathy. This censorship period exceeds that of many other wild turkey telemetry studies (Miller et al. 1995, Nguyen et al. 2003, Willsey 2003). Radio-marked hens were located throughout spring/summer (April 18 - September 1) for two consecutive years (2011 and 2012). Each hen was located 3 times per week, at varying times of day, typically once during each of the morning (sunrise - 10:00 am), afternoon (10:00 am - 4:00 pm), and evening (4:00 pm - sunset) time periods.

Each transmitter had 2 settings, active-mode (55 pulses per minute) and mortality-mode (110 pulses per minute), with the latter commencing after 8 hours of inactivity. To locate a radio-marked hen, I used direction-finding processes outlined by Samuel and Fuller (1994) and Chu et al. (1989) using either a vehicle mounted omnidirectional whip antenna or a handheld 3-element Yagi antenna and an ATS R2000 receiver (Advanced Telemetry Systems, Isanti, Minnesota). For individuals that were not visually observed, azimuths and collection locations were entered into

LOCATE III (Pacer Computer Software, Tatamagouche, Nova Scotia) to derive a triangulated location.

Feature Inventory

Eight habitat features were selected for the habitat use analysis (Figure 3.2). This number complied with the rules of Johnson's (1980) method where the number of habitat types must not exceed the sample size (number of individuals) (White and Garrott 1990); but also allowed for the analysis and ranking of both non-land cover features selected for their potential effect on wild turkey movements (n = 5), and broad land cover features present in the study area (n = 3). Known wintering sites, cattle feedlots, roads, major rivers and creeks, and intermittent streams were selected as the non-land cover features. Locations of sites where turkey were known to overwinter and cattle feedlots in the study area were collected using local knowledge from landowners and sportsmen, and personal observation during both study years. Road and water GIS layers were downloaded from the Manitoba Land Initiative (2001) and altered to include only maintained roadways, and to separate major rivers and creeks (3 watercourses in study area with continual flow) and intermittent streams (small streams and drainages with periodic or seasonal flow). Additionally, agricultural cropland, forests, and grasslands were included in the analysis to assess wild turkey habitat use in relation to land cover. The Land Use/Land Cover Landsat TM layer was downloaded from the Manitoba Land Initiative (2001) and modified due to visual inaccuracies when overlaid with digital orthophoto images of the study area. The Agricultural Cropland class was left unaltered; while Grassland/Rangeland and Forage Crops classes were combined and referred to simply as "grasslands" throughout the analysis; and Deciduous Forests and Open Deciduous Forest/Shrub types classes were combined and referred to as “forests”. Very small patches of Coniferous Forest, Wildfire Areas, Marsh, Cultural Features, and Bare Rock/Gravel/Sand existed within the study area, but were excluded from the analysis. Complete descriptions of the layer’s original land cover/land use classes can be found in Appendix 6.

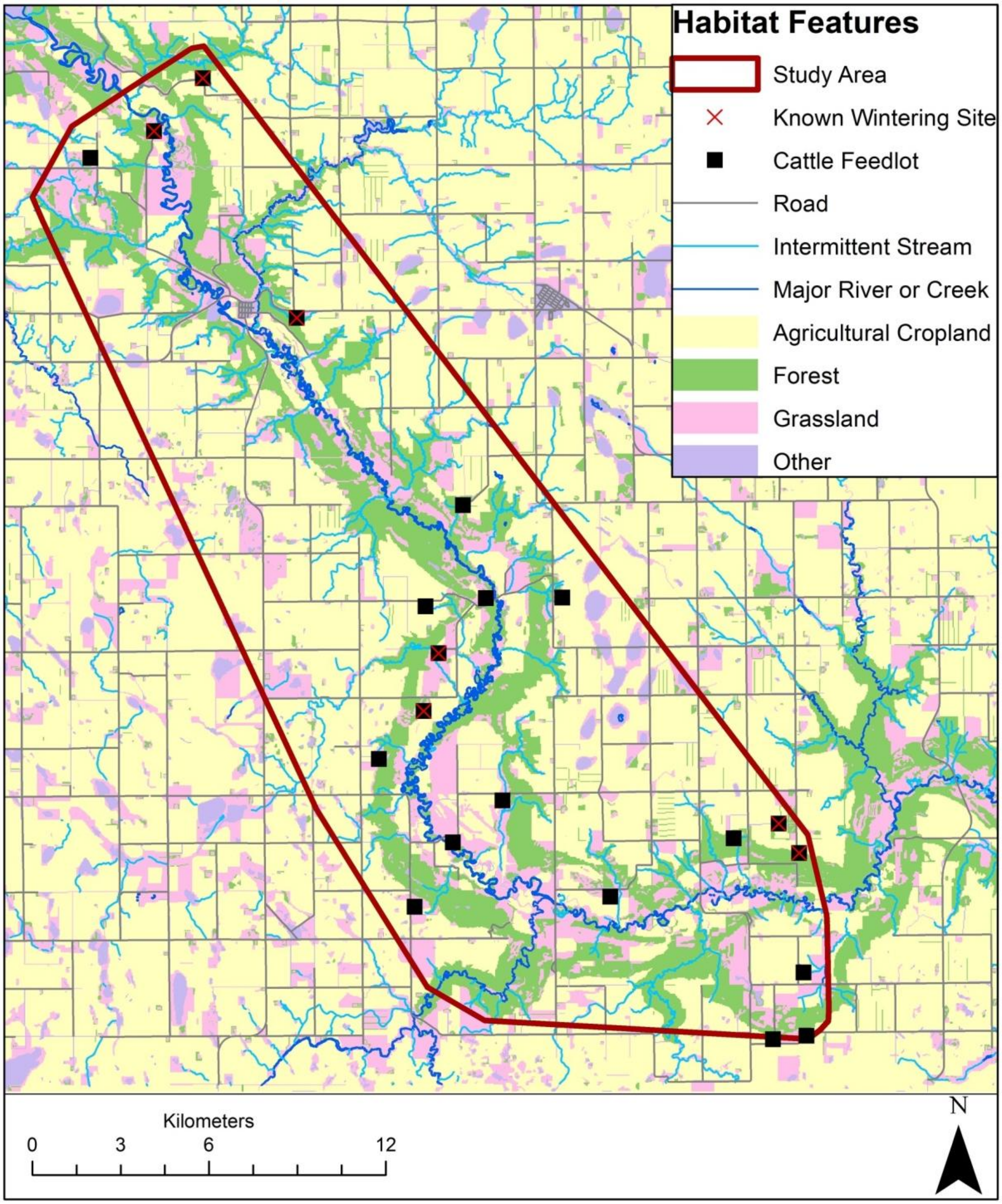

Figure 3.2: Habitat features and their presence within in the study area MCP, that were used to analyze habitat use by radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.

Analysis

Based on Vander Haegen et al. (1988), dispersal distances were calculated as the distance from an individual's wintering site to that individual's first nest site using ArcGIS 10.1 (Environmental Systems Research Institute, Redlands, California). For non-nesting hens dispersal was calculated from that individual's wintering site to a centroid point generated within its spring/summer home range. Dispersal distance for individuals that died before the collection of enough points to calculate a home range (<3 locations) was calculated from either the last known live location or kill site. Year and age effects on dispersal distance were determined using *t-tests*.

Spring/summer home ranges were calculated using Geospatial Modeling Environment 0.6.2.0 (Spatial Ecology LLC). The minimum convex polygons (MCP) method was used based on its prevalence in other wild turkey studies (Hoffman 1991, Badyeav et al. 1996, Miller et al. 1999, Miller and Conner 2007). A calculation using 95% of locations is commonly used for MCP's and other home range methods (Miller et al. 1999, Chamberlain and Leopold 2000, Thogmartin 2001), however software limitations did not allow this, so any potential outliers were eliminated manually before the home-range and habitat use calculation. Only individuals surviving the entire spring/summer period were incorporated into home range and habitat use analyses to ensure that at least 20 locations would be included in each calculation (Thogmartin 2001), and that locations were spread throughout the entire study period. Year and age class effects on home range size were determined using *t-tests*.

Age classes and study years were pooled for the habitat use analysis. Following the guidelines set by Johnson (1980), spring/summer habitat use was analyzed at two spatial scales; the second-order of selection (home range selection within the study area) and the third-order of selection (habitat use within individual home ranges). The Euclidean distance approach (described below) was used to determine habitat use at both spatial scales. Due to the varying levels of error commonly associated with radio-telemetry monitoring, this approach was developed by Connor and Plowman (2001) to eliminate misclassification bias (individual assigned to a certain habitat, when not actually located within it) commonly observed in compositional analyses that use locations with a high level of error or examine habitat use in patchy or fragmented environments. Since distances to the nearest feature are used rather than presence at a particular location, this approach is robust to moderate levels of location error, and in addition to assessing the utilization of habitat patches, it is also able to incorporate point and line features into the analysis (Conner and Plowman 2001, Conner et al. 2003). Since this approach evaluates not only habitats used, but also habitat features that are not directly used by an individual (not necessarily even within its home range), it can be especially useful in a study like this that focuses on seasonal range, where features that are not used may still be important for the individual's annual range and affect home range selection during the season of focus (Conner and Plowman 2001).

Prior to the analysis, ArcGIS was used to generate random locations within both the study area and individual home ranges at a 1:1:1 ratio with the individual turkey locations collected. An equal number of points were generated within each home range as the number of individual points that were used during the creation of that home range, pairing points appropriately. Random locations within the study area were also paired with random points within individual home ranges, assigning each study area point to a certain individual, maintaining the 1:1 ratio. Distances were then calculated from both sets of random points and the individual locations to the nearest representative of each habitat feature, creating a table of distances for use in the analysis.

Starting with the second order, a mean nearest distance from random study area points assigned to each individual (*i*) to each habitat feature was calculated, creating a vector of mean "expected" distances (*r*) to each habitat feature for each individual. Using the distances calculated for random home range points, a second vector of mean "selected" distances (*u*) to each habitat feature was then created. Next, a vector of ratios (*d*) was created for each habitat feature by dividing (u_i) by (r_i). In theory, a ratio (d_i) of 1.0 indicates that a particular habitat feature was selected at random, (d_i) < 1.0 demonstrates that a feature was favored, and (d_i) > 1.0 shows avoidance. Multivariate analysis of variance (MANOVA) was then used to determine if non-random habitat use occurred across all habitat features as a whole, by testing if the mean of (d_i) differed significantly from a control vector of 1.0's using the Wilks-Lambda statistic. If significant, one-way ANOVA results were used to determine which individual habitat features were used disproportionately.

Finally, pair-wise *t-tests* determined if use was associated with one habitat feature over another, and a ranking matrix of habitat features was created (Aebischer et al. 1993). The ranking of habitat features was based on the magnitude of *t*-statistics associated with each habitat type and its comparisons, e.g.) a negative *t*-statistic indicates preference of one feature over another, therefore the greatest number of negative *t*-statistics identifies the highest ranked feature (Conner and Plowman 2001). This same process was then used to evaluate habitat use at the third order, comparing distances calculated for random points generated within individual home ranges and distances calculated for individual turkey locations.

All statistical analyses were conducted using SPSS 21 (IBM Corp., Armonk, New York). Significance was accepted as $P \leq 0.05$ during all analyses, with the exception of pairwise *t*-tests in the habitat use analysis, where a Bonferroni adjustment for multiple comparisons recognizes significant preference of one habitat feature over another at $P \leq 0.002$.

RESULTS

Capture and Monitoring

Twenty-three and twenty female wild turkeys were captured and radio-marked in the winters of 2011 and 2012, respectively (Appendix 1 & 2). No individuals were censored prior to monitoring in 2011; while 4 individuals were censored in 2012, due to mortality ($n = 2$), harness failure ($n = 1$), and unknown signal loss ($n = 1$) during the censorship period. Three turkeys survived through 2011 to the start of the 2012 study year and were incorporated into the analysis as new individuals in 2012.

During the study, 1372 locations were collected through either triangulation or visual observation. Nine individuals from 2011 and 12 individuals from 2012 survived the entire spring/summer study period, averaging 50.2 locations each.

Dispersal

All female wild turkeys dispersed from wintering sites before the start of monitoring (April 18) during both study years, with five hens observed initiating nests by this date in 2012. The movements of 42 turkeys were included in the dispersal analysis (Appendices 7 & 8). Dispersal distances were calculated to 31 first nest sites, nine mean home range points, one last known live location, and one kill location. Distances differed between years ($t_{40} = -2.169$, $P =$

0.36), averaging 6.6 km and 10.3 km in 2011 and 2012, respectively (Table 3.1). Distances also differed between age classes (t_{40} = -3.147, P = 0.003), with adults averaging 6.4 km and juveniles averaging 11.9 km.

Table 3.1: Mean spring dispersal distances in kilometers (including standard deviation, standard error, 95% confidence intervals, minimum distances, and maximum distances) for radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.

		***x* (km)**	***n***	**SD**	**SE**	**95% CI**	**Min**	**Max**
2011								
	All	6.6	23	4.9	1.0	4.5 – 8.7	1.4	19.4
	Adult	5.8	18	4.3	1.0	3.6 – 7.9	1.4	17.9
	Juvenile	9.4	5	6.3	2.8	1.6 – 17.2	3.7	19.4
2012								
	All	10.3	19	6.3	1.5	7.2 – 13.4	1.5	22.9
	Adult	7.7	10	5.8	1.8	3.5 – 11.8	1.5	18.5
	Juvenile	13.2	9	5.8	1.9	8.8 – 17.7	6.6	22.9
Pooled								
	All	8.2	42	5.8	0.9	6.4 – 10.1	1.4	22.9
	Adult	6.4	28	4.9	0.9	4.6 – 8.3	1.4	18.5
	Juvenile	11.9	14	6.1	1.6	8.4 – 15.4	3.7	22.9

Home Range

Twenty-one individuals were included in the home range analysis. This included 18 nesting and 3 non-nesting hens. Home range size did not differ (P > 0.05) by year or age class, averaging 554.4 ha across all individuals (Table 3.2). The minimum spring/summer home range size observed was 243.3 ha, while the maximum was 1283.0 ha.

Table 3.2: Mean home range sizes in hectares (including standard deviation, standard error, 95% confidence intervals, minimum distances, and maximum distances) for radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.

		***x* (ha)**	***n***	**SD**	**SE**	**95% CI**	**Min**	**Max**
2011								
	All	645.7	9	309.9	103.3	407.5 – 884.0	243.3	1283.0
	Adult	613.1	7	349.9	132.3	289.5 – 936.8	306.6	1283.0
	Juvenile	759.9	2	13.8	9.7	636.3 – 883.5	750.2	769.6
2012								
	All	485.9	12	246.4	71.1	329.4 – 642.5	243.3	980.9
	Adult	460.7	4	348.0	174.0	0 – 1013.8	259.4	980.9
	Juvenile	498.6	8	207.2	73.3	325.3 – 671.8	243.3	820.2
Pooled								
	All	554.4	21	280.0	61.1	427.0 – 681.9	243.3	1283.0
	Adult	557.7	11	340.2	102.6	329.2 – 786.2	259.4	1283.0
	Juvenile	550.8	10	213.4	67.5	398.2 – 703.5	243.3	820.2

Habitat Use

Twenty-one female wild turkeys, 11 adults and 10 juveniles, who survived their entire spring/summer study periods, were examined in the habitat use analysis. The study area contained 52% agricultural cropland, 25% forests, 18% grasslands, 7 wintering sites, 21 cattle feedlots, 3 major rivers or creeks, and numerous intermittent streams and maintained roads. MANOVA revealed differences in habitat selection at both the second ($F\ (_{7,\,33}) = 51.123$, $P < 0.001$) and third ($F\ (_{7,\,33}) = 4.563$, $P = 0.001$) orders of selection.

At the 2nd order of selection, home ranges were closer than expected (based on random locations) to cattle feedlots ($F\ (_{1,\,40}) = 86.218$, $P < 0.001$), major rivers and creeks ($F\ (_{1,\,40}) = 25.91$, $P < 0.001$), intermittent streams ($F = (_{1,\,40})\ 33.321$, $P < 0.001$), forests ($F\ (_{1,\,40}) = 58.519$, $P < 0.001$), and grasslands ($F\ (_{1,\,40}) = 73.358$, $P < 0.001$). A ranking matrix of pair-wise *t-tests* revealed that home ranges were selected in relation to forests (1st), cattle feedlots (2nd), and grasslands (3rd) over all other habitat features (Table 3.3).

At the 3rd order of selection, individual locations were located closer than expected to grasslands ($F_{(1, 40)} = 7.752$, $P = 0.008$). Individual locations were farther than expected from major rivers and creeks ($F_{(1, 40)} = 5.563$, $P = 0.023$) and agricultural cropland ($F_{(1, 40)} = 11.407$, $P = 0.002$). A ranking matrix of pair-wise *t-tests* revealed that individuals used areas in relation to grasslands (1st), forests (2nd), and intermittent streams (3rd) over all other habitat features (Table 3.4).

Table 3.3: Pair-wise comparisons and rankings of habitat features used at the 2nd order of selection (home range selection within the study area) by radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.[a]

	Cattle Feedlots		Known Wintering Sites		Roads		Major Rivers and Creeks		Intermittent Streams		Agricultural Cropland		Forests		Grasslands		Rank[c]
All Feedlots			-2.899	(0.006)	-3.569	(0.001)	-1.004	(0.321)	-2.468	(0.018)	-3.566	(0.001)	0.648	(0.521)	-0.411	(0.683)	**2**
Known Wintering Sites	2.899	(0.006)			-1.177	(0.246)	1.958	(0.057)	1.706	(0.095)	-2.152	(0.037)	3.08	(0.004)	2.358	(0.023)	**6**
Roads	3.569	(0.001)	1.177	(0.246)			2.641	(0.012)	3.377	(0.002)	-1.696	(0.098)	4.304	(<0.001)	3.356	(0.002)	**7**
Major Rivers and Creeks	1.004	(0.321)	-1.958	(0.057)	-2.641	(0.012)			-0.772	(0.444)	-2.763	(0.009)	1.721	(0.093)	0.988	(0.329)	**4**
Intermittent Streams	2.468	(0.018)	-1.706	(0.095)	-3.377	(0.002)	0.772	(0.444)			-2.86	(0.007)	3.035	(0.004)	1.789	(0.081)	**5**
Agricultural Cropland	3.566	(0.001)	2.152	(0.037)	1.696	(0.098)	2.763	(0.009)	2.86	(0.007)			3.123	(0.003)	3.041	(0.004)	**8**
Forests	-0.648	(0.521)	-3.08	(0.004)	-4.304	(<0.001)	-1.721	(0.093)	-3.035	(0.004)	-3.123	(0.003)			-1.298	(0.201)	**1**
Grasslands	0.411	(0.683)	-2.358	(0.023)	-3.356	(0.002)	-0.988	(0.329)	-1.789	(0.081)	-3.041	(0.004)	1.298	(0.201)			**3**

[a] table shows *t*-statistic[b] (*p*-values)[d] for each comparison.
[b] a negative *t*-statistic means preference for the feature in the row (feature A) over the feature in the column (feature B). The *t*-statistic tests the null hypothesis that: [mean random study area point (r) distance to feature A/mean random home range point (u) distance to habitat A] – [mean random study area point (r) distance to feature B/mean random home range point (u) distance to habitat B] = 0.
[c] 1 = the highest ranking and most preferred habitat feature. Ranking based on the magnitude of *t*-statistics in each row.
[d] a significant preference for one feature over the other is indicated by $P \leq 0.002$ when a Bonferroni adjustment is applied.

Table 3.4: Pair-wise comparisons and rankings of habitat features used at the 3rd order of selection (selection within home ranges) by radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.[a]

	Cattle Feedlots		Known Wintering Sites		Roads		Major Rivers and Creeks		Intermittent Streams		Agricultural Cropland		Forests		Grasslands		Rank[c]
All Feedlots			-0.972	(0.337)	0.675	(0.504)	-2.174	(0.036)	1.138	(0.262)	-2.898	(0.006)	1.065	(0.293)	2.663	(0.011)	**5**
Known Wintering Sites	0.972	(0.337)			1.193	(0.24)	-2.039	(0.048)	1.684	(0.1)	-2.959	(0.005)	1.281	(0.207)	2.835	(0.007)	**6**
Roads	-0.675	(0.504)	-1.193	(0.24)			-1.905	(0.064)	0.369	(0.714)	-3.299	(0.002)	0.72	(0.476)	1.788	(0.081)	**4**
Major Rivers and Creeks	2.174	(0.036)	2.039	(0.048)	1.905	(0.064)			2.54	(0.015)	-1.459	(0.152)	1.993	(0.053)	3.615	(0.001)	**7**
Intermittent Streams	-1.138	(0.262)	-1.684	(0.1)	-0.369	(0.714)	-2.54	(0.015)			-2.94	(0.005)	0.735	(0.466)	1.153	(0.256)	**3**
Agricultural Cropland	2.898	(0.006)	2.959	(0.005)	3.299	(0.002)	1.459	(0.152)	2.94	(0.005)			2.219	(0.032)	3.749	(0.001)	**8**
Forests	-1.065	(0.293)	-1.281	(0.207)	-0.72	(0.476)	-1.993	(0.053)	-0.735	(0.466)	-2.219	(0.032)			0.041	(0.968)	**2**
Grasslands	-2.663	(0.011)	-2.835	(0.007)	-1.788	(0.081)	-3.615	(0.001)	-1.153	(0.256)	-3.749	(0.001)	-0.041	(0.968)			**1**

[a] table shows *t*-statistic[b] (*p*-values)[d] for each comparison.

[b] a negative *t*-statistic means preference for the feature in the row (feature A) over the feature in the column (feature B). The *t*-statistic tests the null hypothesis that: [mean random home range point (r) distance to feature A/mean individual location point (u) distance to habitat A] – [mean random home range point (r) distance to feature B/mean individual location point (u) distance to habitat B] = 0.

[c] 1 = the highest ranking and most preferred habitat feature. Ranking based on the magnitude of *t*-statistics in each row.

[d] a significant preference for one feature over the other is indicated by $P \leq 0.002$ when a Bonferroni adjustment is applied.

DISCUSSION

All radio-marked wild turkeys in this study had dispersed prior to start of monitoring on April 18 during both study years, despite periodic snow cover occurring throughout April and May, 2011. Snow cover data collected at Morden, Manitoba (~30 km from the study area) specifies that consistent snow cover lasted until March 29, and further snowfall events resulted in snow cover during April 4-5, April 16-21, May 1, and May 13-14 in 2011 (Environment Canada 2010b). In spite of these snowfall events, no radio-marked individuals were observed returning to wintering sites, and no flocks were observed concentrating at wintering sites during opportunistic visits to these sites during the first few weeks of monitoring, suggesting that wild turkeys in this sub-population had already dispersed and established spring/summer home ranges prior to April 18. Consistent snow cover lasted for only 13 days, from March 1-13, during winter 2012 (Environment Canada 2010b). The relatively short period of snow cover, along with five hens observed nesting when monitoring commenced, leads me to suspect that the sub-population had dispersed and established spring/summer home ranges well before April 18, 2012.

Female dispersal patterns observed in this study are consistent with movements observed in other studies, with some aspects occurring at or exceeding the upper range limits previously observed for eastern wild turkeys in North America. Mean spring dispersal by juveniles (10.3 km) was greater than adults (6.6 km), which matches the trend found in most other turkey studies (Ellis and Lewis 1967, Porter 1977, Hayden et al. 1980, Vander Haegen et al. 1988, Miller et al. 1995, Keegan 1996, Timmins et al. 2003), and the general theory that younger individuals of many bird and mammal species disperse father than mature individuals (Smith and Smith 2003). The significant difference observed between years was likely influenced by the higher proportion of juveniles monitored in 2012 (9/19) than in 2011 (5/23). The pooled mean spring dispersal distance in this study (8.2 km) is greater than that of many other eastern wild turkey populations, and the maximum distance recorded in this study (22.9 km) is at the top end of the maximum dispersal range (8.5-24.0 km) recorded by other studies (Ellis and Lewis 1967, Porter 1977, Hayden et al. 1980, Kurzejeski and Lewis 1990, Vander Haegen et al. 1988). Although large distances were recorded in this study, movement corridors, population density, and predation pressure likely had a large influence on the observed movements and other sub-populations in Manitoba may not possess the ability or need to disperse in a similar fashion.

While the definition of spring and/or summer monitoring periods differs greatly among wild turkey studies, and home range sizes will differ based on estimation methods used (Laver and Kelly 2008), the mean spring/summer home range size in this study (554.4 ha) was consistent with other populations in forest-agriculture complexes where annual, spring, and/or summer home ranges average <1000 ha (Ellis and Lewis 1967, Hayden et al. 1980, Bidwell et al. 1989, Kurzejeski and Lewis 1990, Lehman et al. 2003, Timmins et al. 2003). Eastern wild turkey populations in areas dominated by forests and logging, rather than agriculture, typically exhibit mean annual and seasonal home ranges larger than 1000 ha (Wigley et al. 1986, Hayden et al. 1980, Thogmartin 2001), as do Rio Grande wild turkeys in Oregon (Keegan 1996) and Gould's wild turkeys in New Mexico (York and Schemnitz 2003).

Low dispersal and small home range size within a population can result in low genetic diversity, increased disease transmission, and susceptibility to mass mortality events following adverse environmental conditions and low resource availability (Greenwood 1980, Bolen and Robinson 2003, Guiggioli et al. 2006), however the data provided in this study suggests that the movements of turkeys in the Pembina Valley are not detrimental to the sub-population's health. Although relatively small spring/summer home ranges were observed, these calculations included movements occurring after spring dispersal, and the comparatively large dispersal distances observed should counteract their size. Several apparent transmitter harness failures observed during fall 2011 contributing to low 'survival' of radio-marked individuals through to the winter of 2012 did not allow for an analysis of wintering site fidelity, however incidental observations of several radio-marked individuals wintering at alternative sites during the 2012 and 2013 following each spring/summer study period suggests immigration/emigration between wintering flocks does occur. Further analysis of annual home range size for members in this sub-population may reveal that genetic mixing does commonly occur between wintering flocks. Also, the presence of 7 known wintering sites in the study area, sustaining at least 4 wintering flocks, should lower the likelihood of the entire sub-population collapsing as a result of a disease outbreak or adverse environmental conditions.

Wild turkeys in this study selected spring/summer home ranges (representing pre-nesting, nesting, brood rearing, post-brood loss, and non-nesting ranges) that were significantly closer to cattle feedlots, major rivers and creeks, intermittent streams, forests and grasslands than expected, which accurately represents the landscape features that are prevalent in the glacial melt water channel that contains the Pembina River. In relation to the preferred features, this valley contains: the majority of cattle feedlots that are located within the study area; more and larger forest patches and less agricultural cropland in comparison to the plain above the valley; and numerous intermittent streams draining into both the Pembina River and major creeks, that have formed more exaggerated relief changes across the landscape. Further emphasizing how female limited their movements to areas directly around the valley is the fact that the farthest a hen nested away from the valley edge was 1.5 km. Also, home ranges (concentrated along the valley) contained 38% forest, 31% agricultural cropland, and 27% grassland, compared to the entire study area, which was comprised of 52% agricultural cropland, 25% forest, and 18% grassland.

Given that a ratio was created between average distances of individuals and random points to habitat features, land cover and non-land cover features were able to be combined to rank feature importance (Connor and Plowman 2001), resulting in forests, cattle feedlots, and grasslands being classified as the three most important habitat features during home range selection. This preference matches other studies where forests that provide adequate roosting cover (Zwank et al. 1988, Porter 1992), grassy areas ideal for foraging during brood-rearing (Porter 1980, Kurzejeski and Lewis 1990, Porter 1992, Swanson et al. 2004), and cattle production sites used by fall and winter flocks (Vander Haegen 1989, Healy 1992, Parent et al. 2007) are commonly selected by turkeys. Fall and winter movements were not monitored in this study, but the spring/summer results show that cattle feedlots, which are commonly used during fall and winter, remain an important feature after spring dispersal.

Grasslands, forests, and intermittent streams ranked as the three most important habitat features within home ranges, with individuals found significantly closer than expected to grasslands, and significantly farther than expected from major rivers and creeks, and agricultural cropland. The preference for grasslands once again confirms the importance of grassy areas to brood rearing activities, but also nesting cover, since 60% ($n = 47$) of nests observed during this study were concealed in tall grass. The ranking of intermittent streams as the third most favored feature shows the importance of easy access to water sources, which others have suggested are important when selecting roosting (Hurst and Dickson 1992, Chamberlain et al. 2000) and nesting sites (Badyaev 1995). The observed disassociation with major rivers and creeks within home ranges suggests that the intermittent streams in this study area, although varying in size, adequately satisfy the sub-population's needs.

MANAGEMENT IMPLICATIONS

The results of this study suggest that it is possible for wildlife managers to lengthen the spring hunting season, opening it a week earlier, since female wild turkeys had already dispersed and were established on their spring/summer home ranges before the earliest possible season opening date (April 17), even during a winter where consistent snow cover lasted until the end of March and snow fall events continued to occur throughout April and May. When setting spring hunting seasons, Manitoba Conservation and Water Stewardship's goal is to present the best possible opportunity to harvest male turkeys (during periods of peak gobbling), but still leave enough time for flocks to disperse from wintering sites, spreading out hunting opportunity and pressure (Baldwin and Ryckman 2011). The majority of hunters surveyed in Manitoba agree with spring season dates, ranging from 72-83% satisfaction from 2009 to 2012 (Baldwin and Ryckman 2010, Baldwin and Ryckman 2011, Manitoba Conservation and Water Stewardship, unpublished data), but if managers are looking to increase hunting opportunity within the province, lengthening the spring turkey season should be considered. In this study, even during a winter where snow cover existed throughout March, April, and May, turkeys were established (as observed on April 18) on their spring/summer ranges before the traditional opening dates of the spring hunting season (between April 17-23 for the "youth only" season and April 24-30 for the general resident season). Opening both seasons a week earlier would enable hunters to be afield during earlier peaks in gobbling activity that may occur following winters with a short snow cover period (as was the case in 2012), but still allow time for dispersal during winters with prolonged periods of snow cover (as in 2011).

Information from within Manitoba regarding dispersal distances of wild turkeys is useful for determining probable and potential dispersal of birds during introductions and should be used to structure the consultation requirement for new releases. Currently, local wildlife associations that have applied for an introduction or transfer of local birds must conduct consultations with landowners and residents at sites where turkeys are likely to overwinter (Frank Baldwin, Manitoba Conservation and Water Stewardship, personal communication). Based on results of this study, I suggest that Manitoba Conservation and Water Stewardship use the 8.2 km mean dispersal distance as a figure of probable movement, creating a minimum radius around the proposed release site, inside of which the applicants must consult with landowners. In addition to this 8.2 km buffer, special consideration should be given, on a case-by-case basis, to potential movement corridors, and consultation efforts be extended along those features. Although dispersal distances up to 22.9 km, as were recorded in this study, are not likely to occur immediately after introduction, this distance should be used as a guideline for potential movement once the population is established, and should be incorporated into the consultation process (along potential movement corridors) in order to assess any potential future conflicts that may require removals, as has occasionally been the case in the past.

The dispersal distance information collected in this study has been used to create a probable distribution map for wild turkeys in the province (Figure 3.3), which will help prioritize new releases, determining connectivity between existing flocks, and manage existing sub-populations. The distribution map was created by:

1) Determining known locations of wild turkeys by consulting staff from Manitoba Conservation and Water Stewardship's Wildlife Branch and district offices across southern Manitoba.

2) Plotting known locations into ArcGIS 10.1.

3) Buffering each location by 8.2 km (mean dispersal distance in this study) to reflect the probable distribution of flocks.

4) Connecting the portions of buffers that were located within 14.7 km of each other, meaning that connections were made when a probable distribution buffer was within 22.9 km (maximum dispersal distance in this study) of another known location, representing the potential connectivity of flocks.

The subsequent map can be used to prioritize releases based on the probability of natural dispersal to the proposed location without a new introduction, and turkey distribution/saturation in relation to the Game Hunting Area (GHA) where the proposed release is located. Additionally, the map depicts isolated flocks across the province (some in GHA's with turkey hunting seasons, and some without), that should be further inspected by managers to determine if those flocks could use additional birds, and if so, decide if the re-stocking effort is a worthwhile expenditure, based on habitat availability, probability of long-term isolation, historic weather patterns, and suspected predation pressure.

Using the movements of female wild turkeys documented in this study, managers can begin to conduct more thorough habitat assessments when reviewing introduction proposals, by considering land cover composition in a defined area around the proposed introduction site, and identifying the density of cattle feedlots or other agricultural production sites within the same defined area. In this study, female turkeys were found to select home ranges with higher than expected access to forests, grasslands and cattle feedlots. The region in this study is dominated by agricultural cropland (52%), with smaller amounts of forest (25%) and grassland (18%). However, since forests and grasslands were important during home range selection, forest and grassland composition within individual home ranges increased to 38% and 27%, respectively, and the proportion of agricultural cropland decreased to 31%. Based on this, an assessment of the area surrounding a proposed introduction site (8.2 km radius) could use a breakdown of 1/3 forest, 1/3 grassland, and 1/3 agricultural cropland as a general rule for predicting establishment. Also, since most historical and recent introduction sites in the province have been cattle feedlots or other agricultural production sites where non-traditional foods are readily available during winter, and since cattle feedlots were deemed important during home range selection, these sites must be considered as well. The established and seemingly stable Pembina Valley sub-population resides in an area with a density of one cattle feedlot per ~20 km^2. A density of production sites similar to this should be incorporated into the assessment to ensure that an introduced population has potential for dispersal and expansion, and that if the population does expand, they will not necessarily reside at only the one site, possibly creating future agricultural depredation complaints.

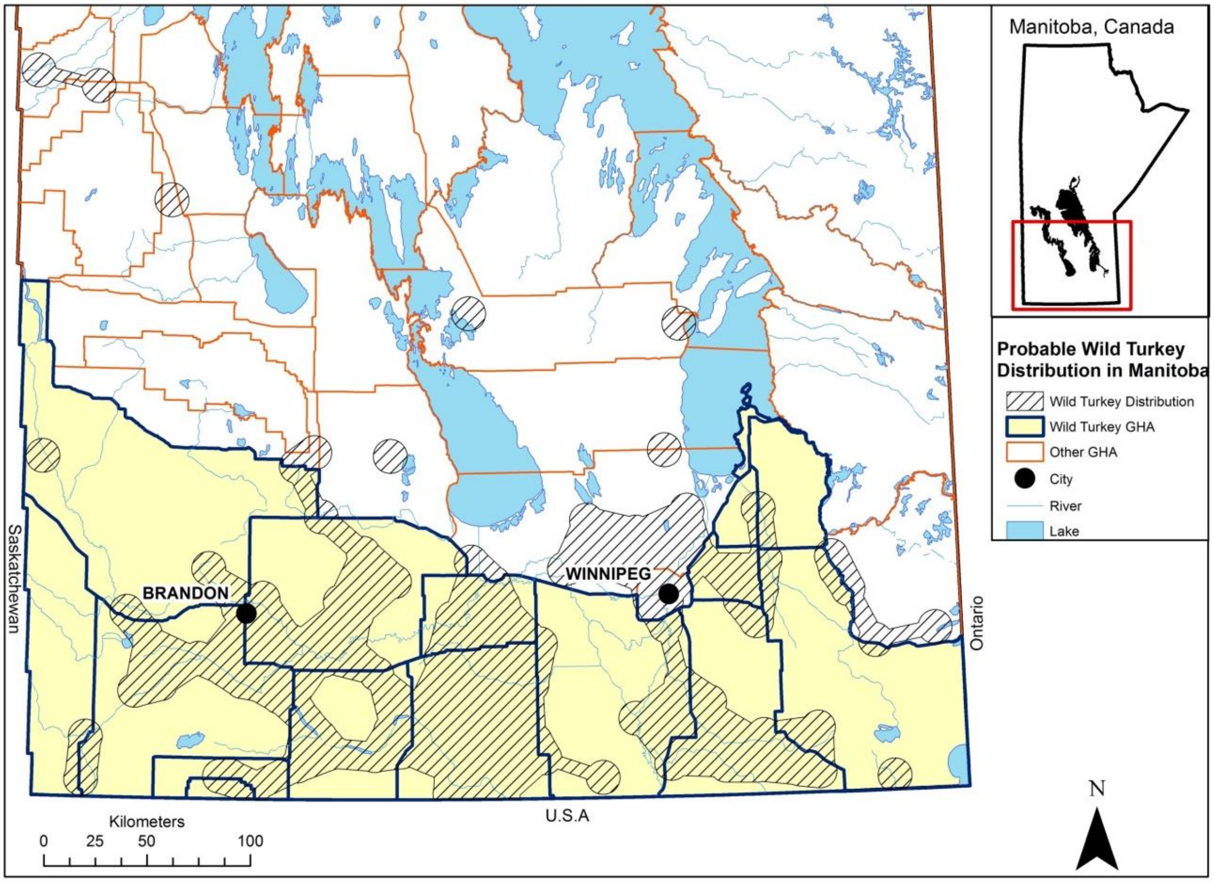

Figure 3.3: Probable wild turkey distribution in Manitoba based on known wild turkey occurrence and estimations of dispersal collected during this study (see text for further explanation of methods).

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CHAPTER 4 – SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The primary objective of this study was to collect the following baseline information on female wild turkeys in Manitoba's Pembina Valley sub-population:

- Estimates of spring/summer survival, cause-specific mortality, nesting and annual hen success, and productivity through natality.
- Knowledge on movement capability, including spring dispersal timing and distances, and spring/summer home range estimates.
- An evaluation of habitat-use during the nesting and brood rearing seasons.

The procurement of this baseline data is useful for assessing the status of current turkey populations, determining limiting factors, managing hunting seasons and harvest, and planning future introductions. Collecting this data from within Manitoba is important because the province exists at the northern edge of the species' North American range, and a study of this nature has never been conducted within the province, despite a population becoming established following introductions dating back to 1958.

A sub-population of turkeys located within the Pembina Valley region of southern Manitoba was targeted for this research based on its suspected size and stability, historic significance dating back to the province's initial introductions, and a high proportion of the provincial harvest occurring within the same general area. The main feature of the study area is the Pembina Valley, a glacial melt water channel composed of steep forested walls containing the Pembina River and scattered sections of agricultural cropland and grassland along the valley floor. Livestock and grain production are the two main industries in the study area.

In order to accomplish the objectives of this study, a total of 43 female turkeys were captured at wintering sites and radio-marked for monitoring. Individuals were located three times a week from April 18 - September 1, for two consecutive years, 2011 and 2012. Daily visual observation and/or telemetry locations, mortality events, and nesting characteristics were collected for further analysis.

In summary, this study estimated the following vital rates for female wild turkeys in the Pembina Valley sub-population:

- 53% cumulative spring/summer survival probability.
- Mammalian predation accounted for 84% of mortalities.
- 27-day variability for the earliest date of nest initiation between study years.
- 82% nesting frequency.
- 29% cumulative nesting success.
- 35% hen success.
- Average clutch size of 11.3 eggs.
- 89% hatching success.
- Natality rate of 2.3 females hatched per female alive at breeding.

Cumulative survival was lower than other northern jurisdictions, but appeared to be influenced by both a high coyote population and 'non-favorable' winter weather in 2011. Low survival in 2011 corresponded with a 17-year high in coyote pelt sales in southern Manitoba, and a 12-year high in coyote-livestock depredation claims in the municipality containing the study area. The winter of 2011 can be characterized as 'non-favorable' due to cold temperatures and prolonged snow cover, while the winter of 2012 was classed as 'favorable' following milder temperatures and only 13 days of snow cover. It is suspected that the winter of 2011 may have resulted in females entering the reproductive season in poorer body condition and without ideal nesting cover due to a delayed growing season, resulting in a higher susceptibility to predation, as reflected in the 26% difference in survival probability between years.

Winter weather also appeared to affect certain nesting parameters, including the timing of the nesting season and nesting success, by first delaying wild turkey's ability to nest, then forcing hens to nest with less than ideal levels of concealment making them more susceptible to predation. The earliest date of nest initiation differed by 27 days between study years, occurring later in 2011 after a 'non-favorable' winter where the number of March days that the maximum temperature was <0° C was 8 days greater than in 2012. Hen success, also seemed to differ between study years in response to winter weather, increasing from 23% in 2011 to 50% after the 'favorable' winter of 2012, likely due to increased survival throughout the reproductive period allowing hens to initiate and successfully hatch third nests.

Having the ability to initiate and hatch third nests during the 2012 study period proved to be beneficial to hen success, considering that cumulative nesting success was the same during both study years, at 29%. This figure is lower than other northern jurisdictions and it can be hypothesized that a differing and more abundant nest predator community may exist within the region.

Productivity in this study, measured by natality, closely resembled rates of 'stable/increasing' populations at northern latitudes, however the 'non-favorable' winter of 2011 did seem to affect production during that study year. Lower nesting propensity and hen success in 2011 resulted in 1.4 females being produced per female alive at breeding compared to 2.8 after the 'favorable' winter of 2012.

Radio-marked female wild turkeys in this study showed the following movement characteristics:

- Dispersed from wintering sites and established their spring/summer ranges prior to April 18 during both study years.
- Dispersed an average of 8.2 km from wintering sites.
- Juveniles dispersed significantly farther (11.9 km) than adults (6.4 km).
- Maximum dispersal distance observed was 22.9 km by a juvenile hen.
- Minimum convex polygon (MCP) home range sizes averaged 554.4 ha.
- Home ranges were selected closer than expected to cattle feedlots, major rivers and creeks, intermittent streams, forests, and grasslands at the 2nd order of selection (home range selection within the study area).
    - Forests, cattle feedlots, and grasslands were ranked 1st, 2nd, and 3rd, respectively, in order of importance.
- Individuals were located closer than expected to grasslands, and farther than expected from major rivers and creeks, and agricultural cropland at the 3rd order of selection (selection within home ranges).
    - Grasslands, forests, and intermittent streams were ranked 1st, 2nd, and 3rd, respectively, in order of importance.

Distances traveled during spring dispersal, which occurred prior to April 18 during both study years (despite snowfall events occurring into April and May in 2011), were relatively high compared to other northern wild turkey studies. Mean dispersal (8.2 km) exceeded averages found elsewhere, while the maximum distance (22.9 km) observed is at the top end of the range documented in other studies.

The average spring/summer home range calculated in this study was similar to other eastern wild turkey populations in forest-agriculture complexes. When evaluated with the relatively high dispersal distances observed and the density of wintering flocks in the study area, it appears that immigration/migration and genetic mixing occurs within this sub-population. Based on the observed movements, there is a low probability that the sub-population could collapse due to isolation and/or a single catastrophic incident, such as a severe weather event or a disease outbreak.

The incidence of all nesting sites being selected close (≤1.5 km) to the Pembina Valley and the determined preference for features that dominate the valley (e.g. forests, grasslands, and cattle feedlots) in comparison to entire study area, signifies the importance of the valley to this sub-population. For example, the study area contained 52% agricultural cropland, 25% forest, and 18% grassland, while home ranges (concentrated along the valley) contained 38% forests, 31% agricultural cropland, and 27% grassland. Within home ranges, the association with grasslands is consistent with the wild turkey's need of grassy areas for nest concealment and brood rearing; while the association with intermittent streams suggests that these features meet their requirements for access to water during roosting and nesting activities, limiting the need for (and observed disassociation with) major rivers and creeks.

The interpretation of this study's results leads to implications for the management of current wild turkey populations and future release efforts within the province. I suggest that the results of this study be used for:

1. Population Modeling - Vital rates and movements observed in this study can be used as baseline parameters when modeling current populations to:
    a. Assess their current health.
    b. Predict the long/short term effects of potential limiting factors, including weather, predation, and harvest.

2. Harvest Management -Spring dispersal patterns and mortality factors in this study suggest that managers:
    a. Could expand spring hunting seasons by opening them a week earlier, which should still allow time for spring dispersal, but also allow hunters to take advantage of earlier peaks in gobbling activity that may occur during years with mild winter/spring weather conditions.
    b. Consider the potential effects of increased legal and illegal hen harvest when expanding hunting opportunity and offering additional wild turkey licenses. Although low, harvest is a factor in hen survival, and multiple options for offering second tags should be explored, including spring-only use, restricting use to certain Game Hunting Areas (GHA's), and using alternative season dates.
3. Planning Future Releases – Based on this two year study, managers should consider the following when planning future releases within the province:
    a. Consult the probable wild turkey range map (Figure 3.3) created using data collected during this study, to prioritize release proposals, based on:
        i. If natural colonization is likely to occur within the given area without the proposed release, using current distribution within the province and verified densities in areas near the proposed release site.
        ii. The current saturation of the GHA in which the proposed release site is located.
    b. Require wildlife organizations to consult with landowners and residents at sites where turkeys are likely to overwinter within a minimum of 8.2 km from the proposed

release site, and extend consultations up to 22.9 km from the release site along potential movement corridors.

c. Predict the probability of population establishment after a proposed release, based on habitat availability:

    i. Use a general 1/3 forest, 1/3 grassland, and 1/3 agricultural cropland breakdown to classify the area surrounding the proposed release site (8.2 km radius) as ‘wild turkey habitat’.

    ii. Require the same area surrounding the proposed release site to have approximately one agricultural production site per 20 km^2, for wild turkeys to use as winter habitat.

To enhance the operability of my previous suggestions, I also recommend that further research be conducted in Manitoba on the following aspects of wild turkey biology:

- Radio telemetry studies investigating survival and movements of males, ideally conducted in the Pembina Valley sub-population, which would provide additional parameters for the population modeling suggested.
- A further investigation of weather effects on turkeys in Manitoba based on some of the hypotheses made following the results of this study.
- Obtain a quantitative inventory of predator richness and abundance in the Pembina Valley to further determine what predator populations are limiting female survival and nesting success in the province of Manitoba.
- Conduct wintering flock and/or spring gobbling counts to refine the probable wild turkey distribution map and determine relative abundance across occupied GHA’s.

- Overlay the probable wild turkey range map with a land cover layer and locations of suitable agricultural production sites to identify vacant habitat in the province.
- Using the above map identifying current wild turkey distribution and habitat availability, investigate isolated flocks to determine their status, and if restocking is needed, decide if it is worthwhile expenditure, based on the likelihood of long-term isolation.

The results of this and future studies on wild turkeys at the northern edge of their North American range stand to further expand our knowledge on turkey ecology at northern latitudes, where many knowledge gaps still exist (Kimmel and Kruger 2007). Going forward, managers must continue to adapt in order to answer questions posed by an ever changing physical, political, and social landscape (Porter et. al 2011). Some issue affecting northern wild turkey regions in the near future, may include:

- For all of the landscapes across the northern fringe of their range that match the land-use composition guidelines suggested in this study, where do you start when planning future introductions?
    - Porter (2007) explains that 'ridge-and-valley topography' in some northern states offers slopes with increased sunlight and reduced snow depths, which is suspected to benefit wild turkeys in the Pembina Valley of Manitoba, as well. Is focusing on these areas in the generally 'flat' northern prairies of Manitoba, North Dakota, Saskatchewan, and Alberta, another key to successful expansion?
- Since turkeys at northern latitudes quite often rely on beef and dairy productions sites during winter, how will populations and management practices react to current declines in these industries?

    - e.g.) Government of Canada census data reveals that the number of farms in Canada reporting beef and/or dairy cattle declined by 41% from 1991 to 2011. Specifically in Manitoba, the number of farms reporting dairy cattle declined from 2214 to 483 (-78%), while the number of farms reporting beef cattle declined from 10,767 to 6,668 (-38%) (Statistics Canada 2011).
- Being an ‘exotic’ species, how should managers react to a possible increase in general opposition towards further expansion of wild turkey populations outside of their ancestral range?
    - e.g.) Kimmel and Kruger (2007) found that 10 of 18 wildlife agencies from the northern U.S.A. and Canada identified that they’ve received some opposition towards turkey expansion efforts.
- How will managers and wildlife groups in northern jurisdictions respond to changing political priorities and direction, and declining funding (Porter et al. 2011)?
    - e.g.) Specific to Canadian provinces, the National Wild Turkey Federation recently canceled all of its fundraising operations in Canada in early 2014 (Manitoulin Expositor 2014).

In the near-future wild turkey managers will be required to answer questions such as these, stressing the importance of maintaining and expanding biological databases, similar to the information presented in this study. This will help ensure that effective management continues to occur, allowing this species to persist and thrive across North America for future generations to value and enjoy.

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APPENDICES

Appendix 1: Written requirement for the University of Manitoba's animal care committee approval of a study involving radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.

University of Manitoba
Synopsis of PI-Directed Wildlife Training for Wild Turkey Capture, Release and Monitoring Research
Brian Kiss, Researcher, Department of Environment and Geography, University of Manitoba

Guiding Policies/Animal Use Protocol
All research will be conducted in accordance with the guidelines provided by the Canadian Council on Animal Care (CCAC) for the Care and Use of Wildlife, 2003 and Species-specific Recommendations on: Birds. The Fort Garry Campus Protocol Management and Review Committee (PMRC) will review procedures used in the context of our field research annually.

Government and Wildlife Regulations
Manitoba Conservation has initiated this research; therefore, no permits are necessary as stated in the Manitoba Wildlife Act:
"An officer may capture or kill wildlife or exotic wildlife for the purpose of protecting property or public safety, research or the management of wildlife or exotic wildlife"
Manitoba Conservation personnel will be present during all capture activities, and has initiated the purchase and attachment of radio transmitters on animals. Radio telemetry devices used in this study are governed by the conditions stipulated by Industry Canada, Spectrum Management Operations Branch (Radio License Numbers 5110817, 5111547, and 5111548 for the Manitou, Brandon, and Rivers study areas).

Potential Health Risks to Personnel
This research requires that personnel work in a field setting and handle live Wild Turkeys during capture operations. Before participating personnel must be aware of any potential risks and be prepared to take preventative measures to reduce such risks, including:
Predation, Parasitism & Disease
All capture operations will take place at controlled farm sites in southern and western Manitoba. Although it is unlikely, there may be some large predator (wolf or coyote) presence at these sites, attracted by the concentration of turkeys and other prey species at livestock feeders. Personnel should constantly be aware of their surroundings, and attempt scare-off (yell, honk vehicle horn) any nuisance animal before a conflict occurs. Furthermore, personnel will be working in groups during capture operations, ensuring a safer work environment. Researchers should use caution when investigating tagged bird mortalities during monitoring sessions, as predators (wolf, coyote, and black bear) are known to frequent the study area. Researchers may be required to enter cattle pastures during investigations. Before entering, they are advised to contact landowners in an attempt to identify problem animals and site concerns.
Male and occasionally female Wild turkeys possess metatarsal spurs on their lower legs. In older birds these spurs can have a sharp tip and grow to a length of two inches. Before handling captured turkeys researchers will be instructed on proper handling techniques and will be

encouraged to wear work gloves (provided). If a puncture wound is inflicted, the wound should be bled for approximately one minute, then washed with an antiseptic solution. Pressure should be applied on the wound to allow for coagulation, and then bandaged appropriately. A first aid kit will be provided on-site during all capture operations.

Captured turkeys will urinate and defecate during the capture and banding process. Researchers should avoid transferring any excreta to their mouth or nose during the handling process. An alcohol-based hand sanitizer will be provided on-site for cleansing once the handling process is finished. Gloves and clothing can become soiled over time and should be cleaned after every turkey capture session.

Rabies – research personnel should avoid mammals (including domestic dogs) that are behaving an aggressive fashion. If an animal observed is suspect to having rabies, it should be either reported to the landowner (in the case of a domestic dog) or reported to the appropriate Manitoba Conservation Office (for wildlife). Should an incident do occur, a rabies vaccination program will be available at the nearest hospital or through the researcher's personal physician.

Lyme disease – researchers should check for and remove deer ticks daily during the spring and summer field season.

West-Nile virus – this virus is carried by mosquitoes and cannot be completely avoided. Personnel should take precautions to reduce their exposure to mosquitoes during the spring, summer, and fall. It is suggested that researchers either carry an insect repellant that contains DEET (used in small doses) or mosquito-proof clothing (a bug net and/or bug jacket).

Tularemia – this disease, caused by the *Francisella tularensis* bacterium, can be contracted by handling or ingesting the tissue of infected animals, or transmitted by biting insects. Symptoms can include slow-developing ulcerations, swollen lymph nodes, pneumonia-like breathing difficulties, sore throat, abdominal pain, vomiting, and diarrhea. Researchers experiencing any of the above symptoms should contact a physician for treatment. Preventative measures include the use of gloves, hand washing, wearing bug repellant, wearing mosquito-proof clothing, checking for ticks, and avoiding contact with open wounds on animals.

Drug or other Equipment/Procedural Hazards

All motor vehicles used for communicating to and from capture sites, and used during the monitoring process should be operated in accordance with all applicable laws governing their use. Research personnel should under no circumstances operate motor vehicles or handle animals while intoxicated.

Other Environmental Hazards

Fieldwork associated with this study involves exposure to various temperature and weather extremes. Personnel should be prepared to experience a variety of weather conditions when planning to conduct fieldwork. Individuals are encouraged to dress in layers, which can be shed in warm weather, and applied in cold weather. Researchers should always carry the following items:

- A light or heavy weight wicking layer (depending on the season, to wick sweat away form the body)
- One or more insulating layers (amount depends on the season)
- A weatherproof shell (to repel precipitation and wind)
- A hat (to prevent excessive exposure to UV radiation)
- Sunglasses (to protect the eyes from UV radiation)

- Gloves (for protect the hands when handling birds, and keeping hands warm in cold weather)
- Proper footwear (suitable for the season and conditions)
- Sunscreen (for UV protection)

Research personnel are advised to hydrate themselves throughout the course of the day and carry an appropriate amount of food.

Emergency Preparedness

A first aid kit is to be on-site during capture activities and kept in the vehicle being used during monitoring. All incidents should be reported to the principle investigator, Brian Kiss, who can be reached at the number below.

Contact Numbers:
Brian Kiss, University of Manitoba, [redacted]
[redacted], Manitoba Conservation, [redacted]
Manitou Office, Manitoba Conservation, [redacted]
Brandon Office, Manitoba Conservation, [redacted]

Procedural Considerations

The purpose of this research is to monitor Wild Turkey populations in a manner that is safe for both the researcher and each individual animal handled and monitored during the study. By no means will animals be intentionally harmed.

Capture

Wild Turkeys will be captured using a Martin Net-blaster (Wildlife Control Supplies, East Granby Connecticut) and occasionally walk-in traps made from welded steel; both using grain as bait. The net-blaster shoots a 40' x 60' net made with 2" mesh designed for use with Wild Turkeys. Personnel using net-launchers will receive training to ensure the safe operation of the device. Wild Turkey capturing activities will only be conducted during the winter months. Relatively cold temperatures exhibited during this season guarantees that captured individuals will not become stressed and overheated to the point where they begin suffer. It is not uncommon for turkeys captured under nets to loose a moderate amount of feathers. Previous capture and relocation studies conducted by Manitoba Conservation have revealed that the majority of feathers are replaced within two weeks of capture. Individuals loosing an excessive amount of feathers will only be measured and affixed with a leg band, not a radio-transmitter, to ensure that the bird does not receive any additional stress. On some occasions white-tailed deer may be lured in front of the net-launcher by the bait. If this happens the net-launcher will not be triggered, and the deer will be harassed in a manner that only promotes the deer to leave, and does not cause any lasting stress.

Restraint

All personnel will receive hands-on training on appropriate methods of removing birds from nets and restraining birds during data collection and tagging. As stated, turkeys can be expected to loose feathers during handling, however when handled in an appropriate fashion, feather loss can be minimal. Once removed from nets, turkeys are handled with one hand holding the bird's legs and the other holding the bird close to the researchers body. Turkeys are then placed in specialized transport boxes (National Wild Turkey Federation, Edgefield South Carolina) in which they are weighed. Birds are then removed from their box, placed on a flat surface with their head covered, and restrained by one observer, who holds the bird's body down with one hand and its legs in the other. Once all pertinent data is collected and the appropriate tags affixed the bird is to be released.

Leg Bands
Each turkey captured will be marked with an appropriate sized aluminum rivet band (National Band and Tag, Newport Kentucky, size 8A for females and 9 for males). Individually numbered and colored bands are to be placed on the right metatarsal of each bird. These bands are attached using a rivet gun and stainless steel rivets. The only caution that personnel should take is to use the appropriate band based on the bird's sex. Typically female bands will not fit on males, while male bands on females will appear loose. Any problems should be easily avoided, since the bags containing each band size are clearly marked.
Radio Transmitters
Backpack style radio transmitters (Advanced Telemetry Systems, Isanti Minnesota, Model A1540) are to be attached onto select females for monitoring purposes. Only experienced personnel will attach transmitters. Transmitters weight 80 grams, which works out to be approximately 2.5% of the mean female body weight in our study area. This is well below the 5% maximum outlined by the CCAC. These transmitters sit on the back of the individual with the antenna extending down the bird's saddle resting on the tail coverts. Each transmitter is attached using a single piece of shock-cord approximately 24 inches in length. This cord is passed through the transmitter, wrapped around each shoulder and passed back through the transmitter where the ends are tied off. In general, a researcher should be able to place two fingers between the bird's back and the transmitter. This fit ensures that a transmitter is not loose enough to fall off or get caught on any obstruction, but not tight enough to irritate the bird.
Transport/Holding
Individuals that are transported for releases in different areas will be done so in the specialized transport boxes used during weighing. If holding sites are used before release, they will meet the requirements outlined in the *CCAC species-specific recommendations on: birds.*
Euthanasia
A representative from Manitoba Conservation will be present during capture activities. In the rare case that an animal is injured during capture, the qualified Manitoba Conservation personnel will humanly euthanize the animal to prevent further suffering. Research personnel are not permitted to euthanize wildlife. If injured animals are observed during the monitoring process, they are to be reported to the appropriate Manitoba Conservation Office (see contact list).
Environmental Impact
Research personnel must clean up the capture site after every use. Do not leave litter (empty grain sacks) on the farm site, and leave the equipment that is to stay on-site in a safe and organized fashion (net folded up, the net launcher's pressure relieved, all other equipment store in the on-site trailer). After the capturing season, all equipment is to be removed from each site. Personnel should use caution during the monitoring process to avoid causing excessive damage to unmaintained roads, pastures, and agricultural fields that they may be required to drive on. If research is to be conducted on private property, the researcher must acquire landowner permission before proceeding with the work plan.

Appendix 2: Descriptions of all female wild turkeys from the Pembina Valley sub-population of southern Manitoba that were captured and radio-marked during winter 2011 for a spring/summer (April 18 – September 1) monitoring study conducted in 2011 and 2012.

Year	Banding Site	Date	Hen ID	Age[a]	Band #	Transmitter Frequency	Condition	Beard (mm)	Weight (kg)	Monitoring Status
2011	1a	2-Feb	2011_032	A	MB-010105	170.032	Good	-	4.84	Active - 1 Year
			2011_081	A	MB-010117	170.081	Good	-	5.13	Active - 1 Year
			2011_112	A	MB-010116	170.112	Good	100	4.80	Active - 1 Year
			2011_140	A	MB-010110	170.140	Good	-	4.37	Active - 1 Year
			2011_201	A	MB-010109	170.201	Good	-	5.10	Active - 1 Year
			2011_262	J	MB-010116	170.262	Good	-	5.00	Active - 1 Year
			2011_321	J	MB-010106	170.321	Good	-	4.05	Active - 1 Year
			2011_342	J	MB-010103	170.342	Good	-	4.05	Active - 1 Year
	2	4-Mar	2011_052	A	MB-010247	170.052	Good	-	3.77	Active - 1 Year
			2011_072	A	MB-010245	170.072	Good	165	4.07	Active - 1 Year
			2011_101	A	MB-010250	170.101	Good	-	3.77	Active - 1 Year
			2011_222	A	MB-010237	170.222	Good	175	4.13	Active - 1 Year
			2011_332	A	MB-010238	170.332	Good	-	3.47	Active - 2 Years
			2011_350	A	MB-010143	170.350	Good	-	4.57	Active - 1 Year
			2011_062	J	MB-010249	170.062	Good	-	3.41	Active - 1 Year
	1b	27-Mar	2011_152	A	MB-010188	170.152	Good	-	4.54	Active - 1 Year
			2011_211	A	MB-010182	170.211	Good	-	4.70	Active - 1 Year
			2011_230	A	MB-010185	170.230	Good	-	4.31	Active - 1 Year
			2011_381	A	MB-010187	170.381	Good	-	4.56	Active - 1 Year
			2011_421	A	MB-010183	170.421	Good	-	5.41	Active - 1 Year
			2011_501	A	MB-010190	170.501	Good	-	4.52	Active - 2 Years
			2011_511	A	MB-010179	170.511	Good	-	5.02	Active - 1 Year
			2011_170	J	MB-010189	170.170	Good	-	4.24	Active - 2 Years

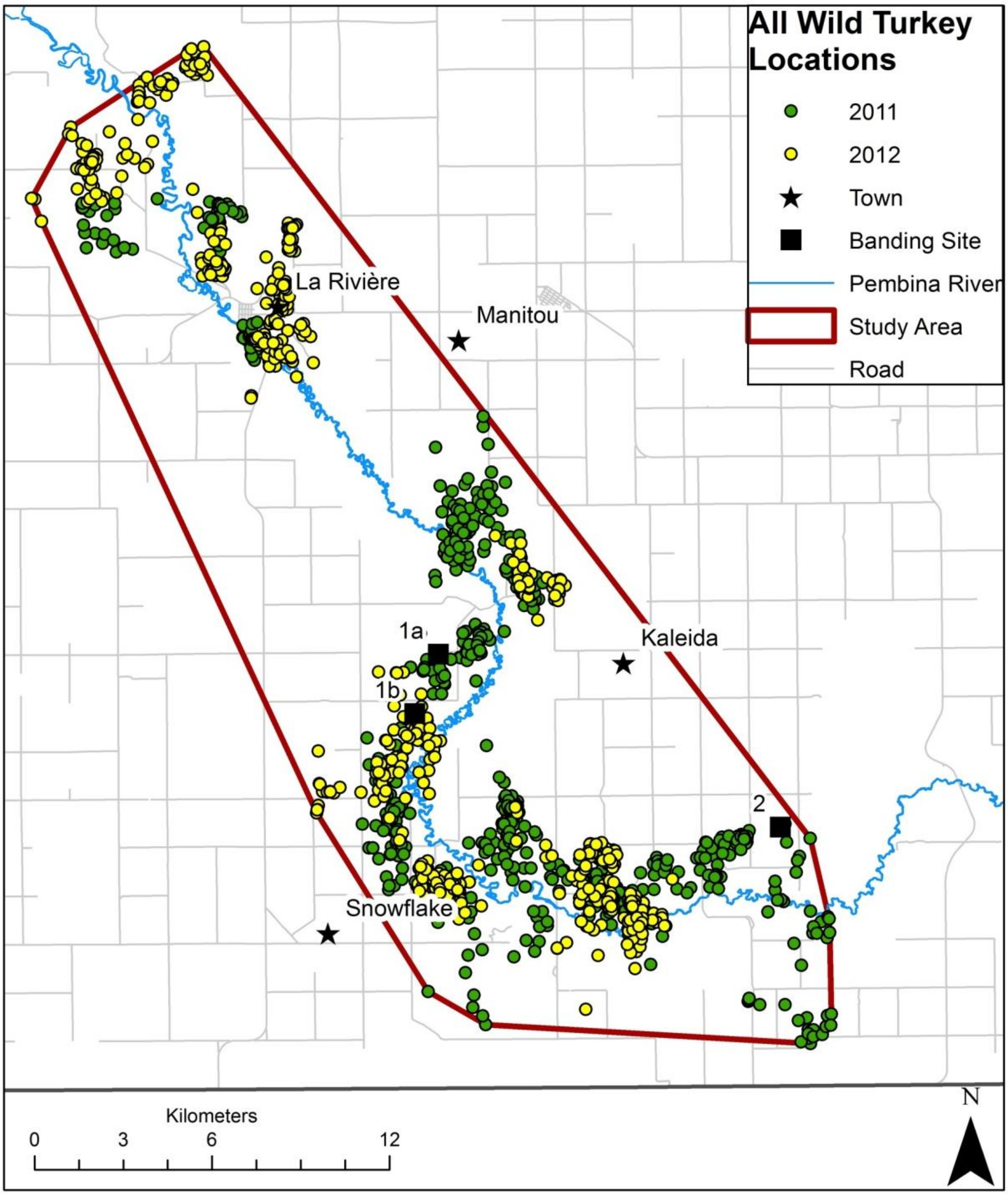
[a] A = adult, J = juvenile.

Appendix 3: Descriptions of all female wild turkeys from the Pembina Valley sub-population of southern Manitoba that were captured and radio-marked during winter 2012 for a spring/summer (April 18 – September 1) monitoring study conducted in 2011 and 2012.

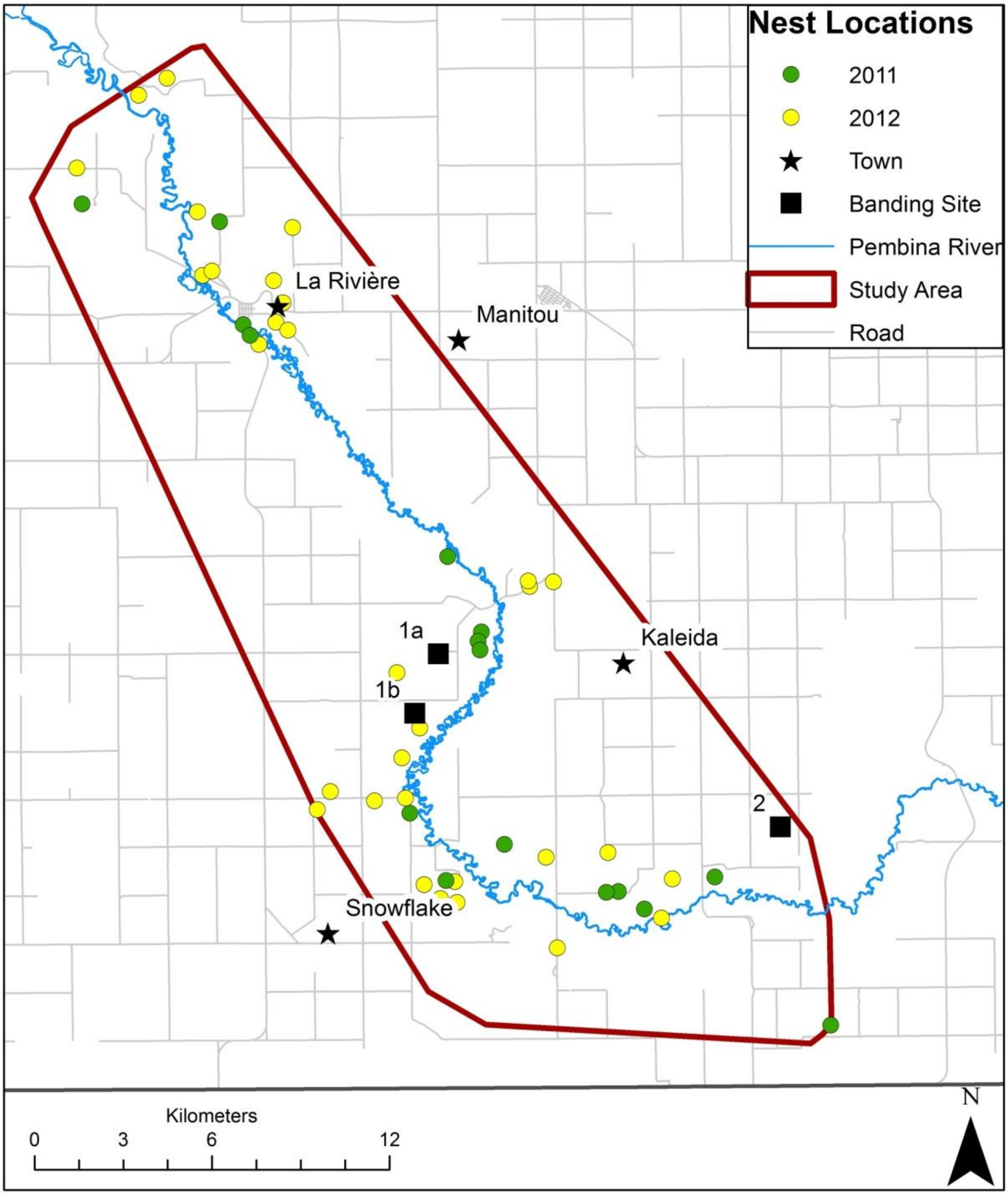
Year	Banding Site	Date	Hen ID	Age[a]	Band #	Transmitter Frequency	Condition	Beard (mm)	Weight (kg)	Monitoring Status
2012	1b	1-Feb	2012_062	A	MB-010170	170.062	Good	-	-	Active - 1 Year
			2012_121	A	MB-010167	170.121	Good	-	-	Active - 1 Year
			2012_201	A	MB-010164	170.201	Fair	-	-	Censored
			2012_262	A	MB-010171	170.262	Good	-	-	Active - 1 Year
			2012_321	A	MB-010174	170.321	Good	-	-	Active - 1 Year
			2012_521	A	MB-010166	170.521	Good	-	-	Active - 1 Year
			2012_032	J	MB-010176	170.032	Good	-	-	Censored
			2012_072	J	MB-010165	170.072	Fair	-	-	Active - 1 Year
			2012_140	J	MB-010173	170.140	Good	-	-	Active - 1 Year
			2012_190	J	MB-010169	170.190	Good	-	-	Active - 1 Year
			2012_342	J	MB-010172	170.342	Good	-	-	Active - 1 Year
			2012_350	J	MB-010175	170.350	Good	-	-	Active - 1 Year
			2012_511	J	MB-010168	170.511	Fair	-	-	Censored
			2012_530	J	MB-010178	170.530	Good	-	-	Active - 1 Year
	1b	29-Feb	2012_101	A	MB-010402	170.101	Good	-	5.08	Active - 1 Year
			2012_211	A	MB-010406	170.211	Good	-	5.04	Active - 1 Year
			2012_222	J	MB-010405	170.222	Good	-	4.17	Censored
			2012_432	J	MB-010401	170.432	Good	-	3.64	Active - 1 Year
			2012_562	J	MB-010404	170.562	Good	-	4.30	Active - 1 Year
			2012_591	J	MB-010403	170.591	Good	-	4.26	Active - 1 Year

[a] A = adult, J = juvenile.

Appendix 4: All locations (visual observation or radio telemetry) collected from radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.



Appendix 5: All nest locations (visual observation or radio telemetry) of radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.



Appendix 6: Original classes in the Manitoba Land Initiative's Land Use/Land Cover Landsat TM layer (as stated in the metadata) (Manitoba Land Initiative 2001).

<u>Land Use/ Land Cover classes for Manitoba</u>

1) Agricultural Cropland: Lands dedicated to the production of annual cereal, seed and specialty crops. These lands would normally be cultivated on an annual basis.

2) Deciduous Forest: Forest lands where 75% to 100% of the tree canopy is deciduous. Dominant species include trembling aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), and white birch (*Betula papyrifera*). May encompass small patches of grassland, marsh or fens less than two hectares in size. Dense forest canopy (>60%), open canopy (26-60%), sparse canopy (10-25%).

3) Water: Bodies Consists of all open water – lakes, rivers, streams, ponds, lagoons

4) Grassland/Rangeland: Lands of mixed native and/or tame prairie grasses and herbaceous vegetation. May also include scattered stands of shrub such as willow (*Salix* spp.), choke-cherry (*Prunus* spp.*)*, saskatoon (*Amelanchier* spp.) and pincherry (*Prunus* spp.). Lands may be used for the harvesting of hay while others may be grazed. Both upland and lowland meadows fall into this class. There is normally (<10%) shrub or tree canopy.

5) Mixedwood Forest: Forest lands where 26% to 74% of the tree canopy is coniferous. May encompass treed bogs, marsh or fens less than two hectares in size. Dense forest canopy (>60%), open canopy (26-60%), sparse canopy (<26%).

6) Marsh: Wetlands comprised of various herbaceous species. Wetlands range from intermittent inundated (temporary, seasonal, semi-permanent) to permanent depending on the current annual precipitation. Common vegetation species include; sedge (*Carex* spp.), whitetop (*Scolochloa festucacea*), giant reed grass (*Phragmites australis*), prairie cordgrass (*Spartina pectinata*), mannagrass (*Glyceria* spp.), slough grass (*Beckmannia* spp.), cattail (*Typha* spp.), and bulrush (*Scirpus* spp.).

7) Bogs: Wetlands dominated by bryoid-mosses (ie. *Spaghnum* spp.) and ericaceous shrubs such as labrador tea (*Ledum* spp.). Tamarack (*Larix larcina*) and black spruce (*Picea mariana*) are also found with a sparse to dense (10 – 100%) canopy.

8) Treed Rock: Lands of exposed bedrock with less than 60% tree canopy. The dominant tree species include jack pine (*Pinus banksiana*), and/or black spruce (*Picea mariana*) with shrub cover such as alder (*Alnus* spp.). Open canopy (26-60%), sparse canopy (10-25%).

9) Coniferous Forest: Forest lands where 75-100% of the tree canopy is coniferous. Jack Pine, white spruce (*Picea glauca*) and black spruce are the dominant species in this class. May include patches of treed bog, marsh and/or fens less than two hectares in size. Dense forest canopy (>60%), open canopy (26-60%), sparse canopy (10-25%).

10) Wildfire Areas: Forest lands that have been recently burnt (< 5 years) with sporadic regeneration and can include pockets of unburned trees.

11) Open Deciduous: Forest/Shrub. Lands characterized by shallow soils and/or poor drainage which support mainly a cover of shrubs such as willow (*Salix* spp.), alder (*Alnus* spp.), Saskatoon (*Amelanchier* spp.) and/or stunted trees such as trembling aspen, balsam poplar and birch with a sparse (10-25%) to open canopy (26-60%).

12) Forage Crops: Agricultural lands used in the production of forage such as alfalfa and clover or blends of these with tame species of grass. Fall seeded crops such as winter wheat or fall rye may be included here.

13) Cultural Features: Cities, towns, villages and communities with place names. Also includes; cemeteries, shopping centres, large recreation sites, autowreck yards, airports, cottage areas, race tracks and rural residential.

14) Forest Cutovers: Forest lands where commercial timber have been completely or partially removed by logging operations.

15) Bare Rock/Gravel/Sand: Lands of exposed bedrock, gravel and/or sand dunes and beaches with less than 10% vegetation. Also includes gravel quarry/pit operations, mine tailings, borrow pits and rock quarries.

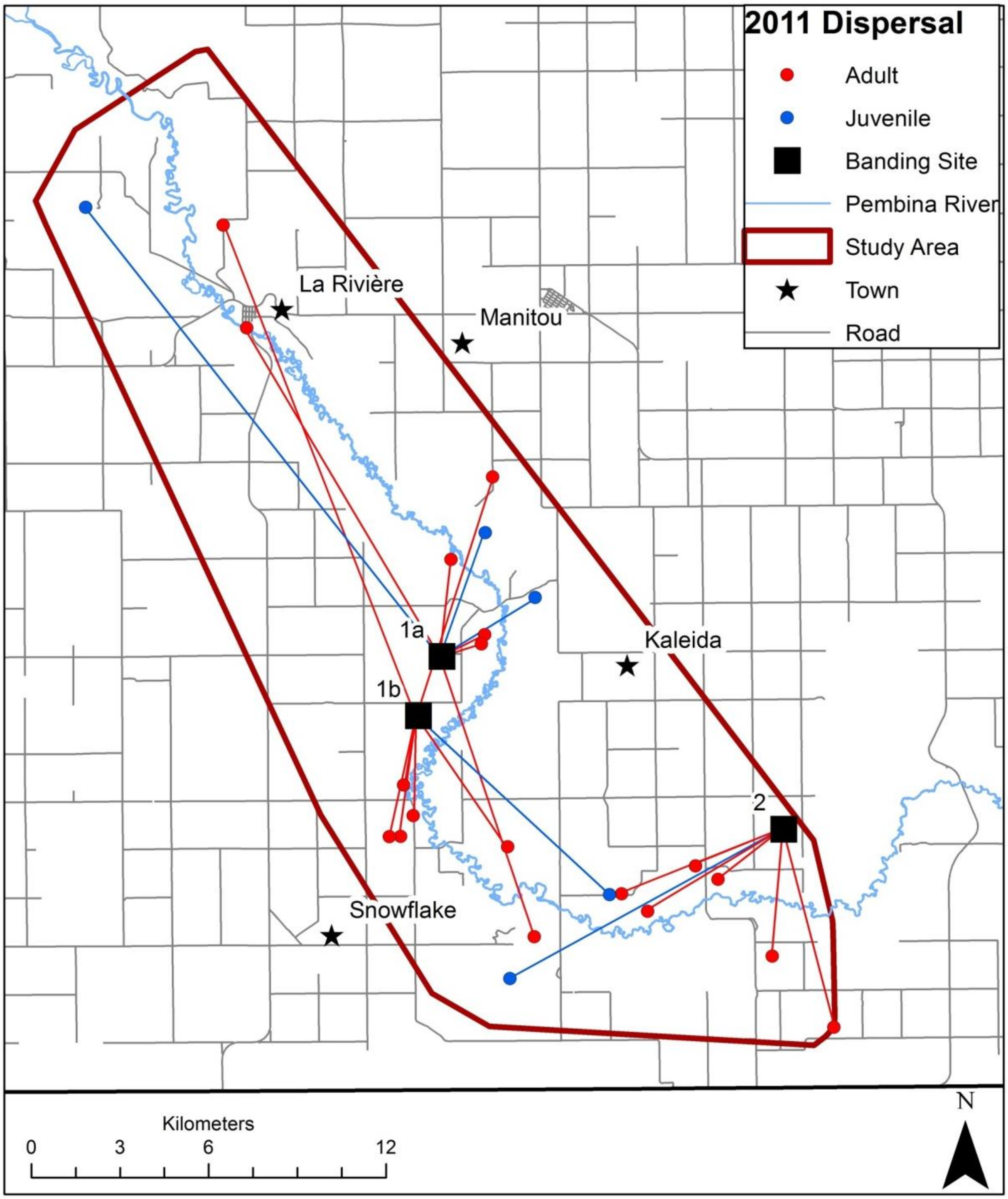
16) Roads/Trails: Highways, secondary roads, trails and cut survey lines or right-of-ways such as railways and transmission lines.

17) Fen: Wetlands with nutrient-rich, minerotrophic water, and organic soils composed of the remains of sedges (*Carex* spp.) and/or mosses (*Drepanocladus* spp.), where sedges, grasses, reeds and moss predominate but could include shrub and sparse tree canopy of black spruce and/or tamarack. Much of the vegetative cover of fens would be similar to the vegetation zones of marshes.

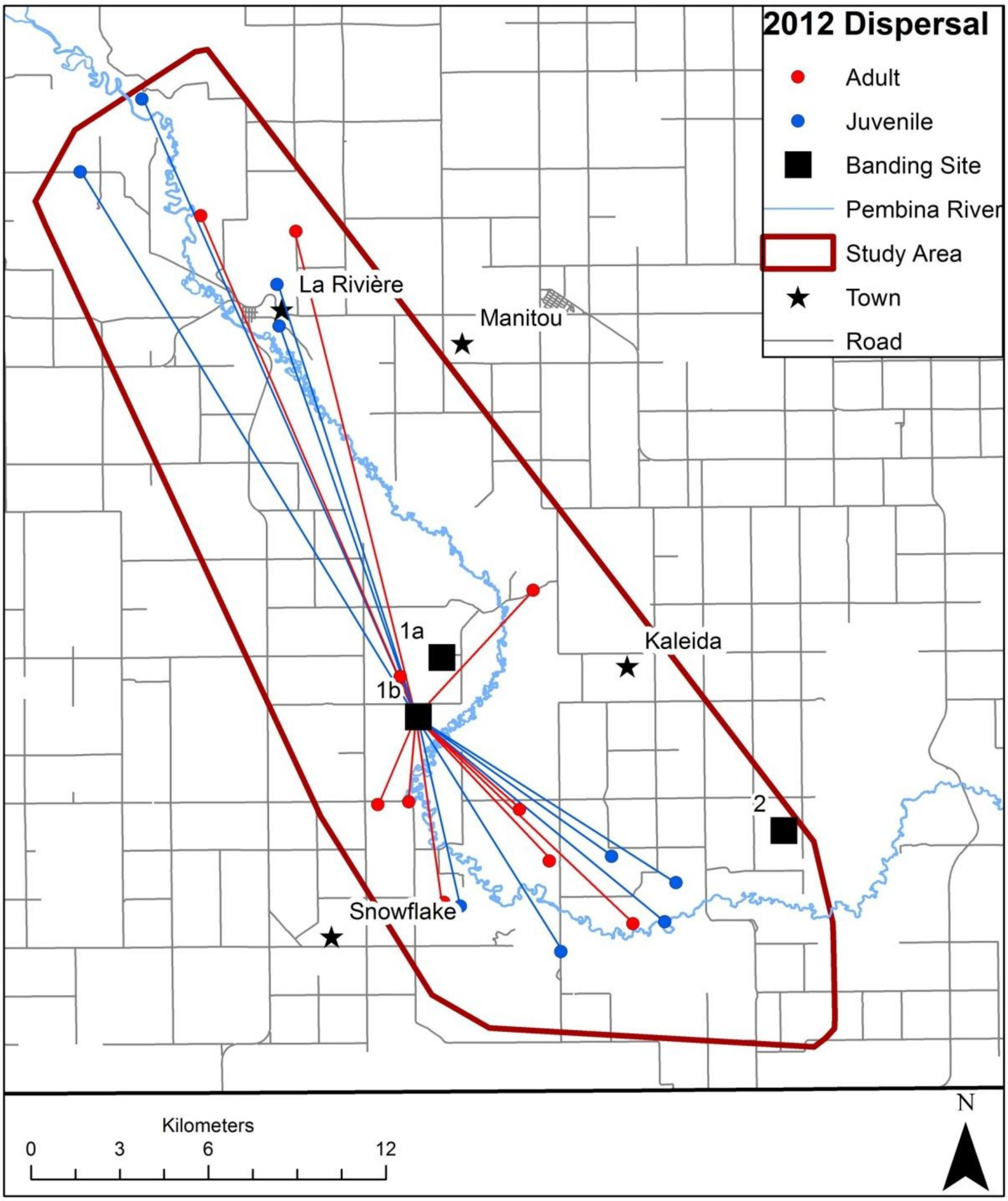
18) Lichen Heath: Lands characterized by an abundance of lichen (*C. alpestris*, *C. mitis*, *C. rangerferina*) and heath vegetation *(L. decumbens*, *V. vitis-idaea*, *V. uglinosum*, *E. nigrum*) located on well drained summits and upper slopes. The forest canopy is sparse (< 10%) with the dominant tree being black spruce. Lichen heath is typically found in the taiga shield ecozone.

Manitoba Land Initiative. 2001. Online database of downloadable digital maps, made available by the Government of Manitoba, Conservation and Water Stewardship. <http://mli2.gov.mb.ca/index.html>. Accessed 1 Apr 2013.

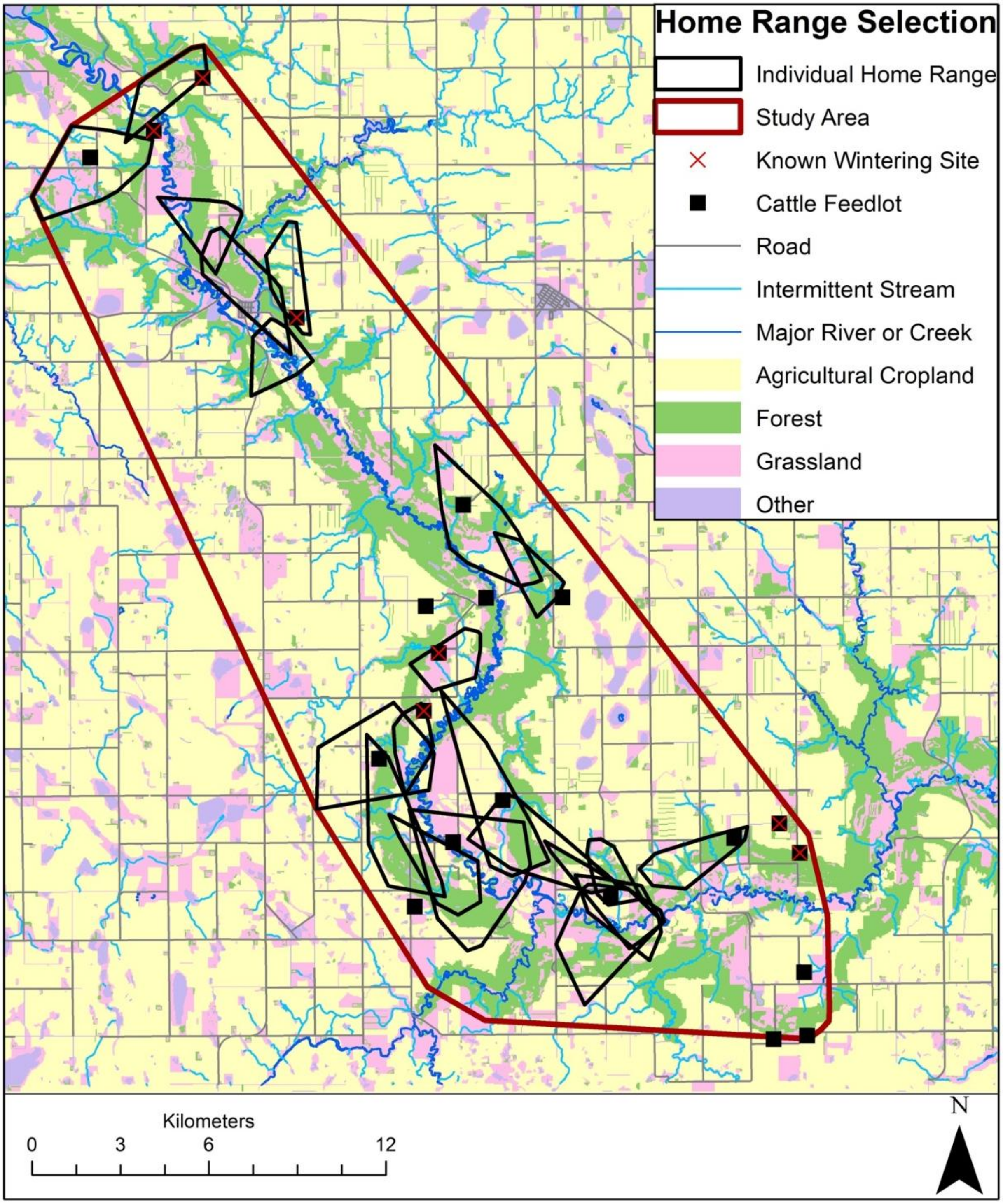
Appendix 7: Spring dispersal observed during 2011, by radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.



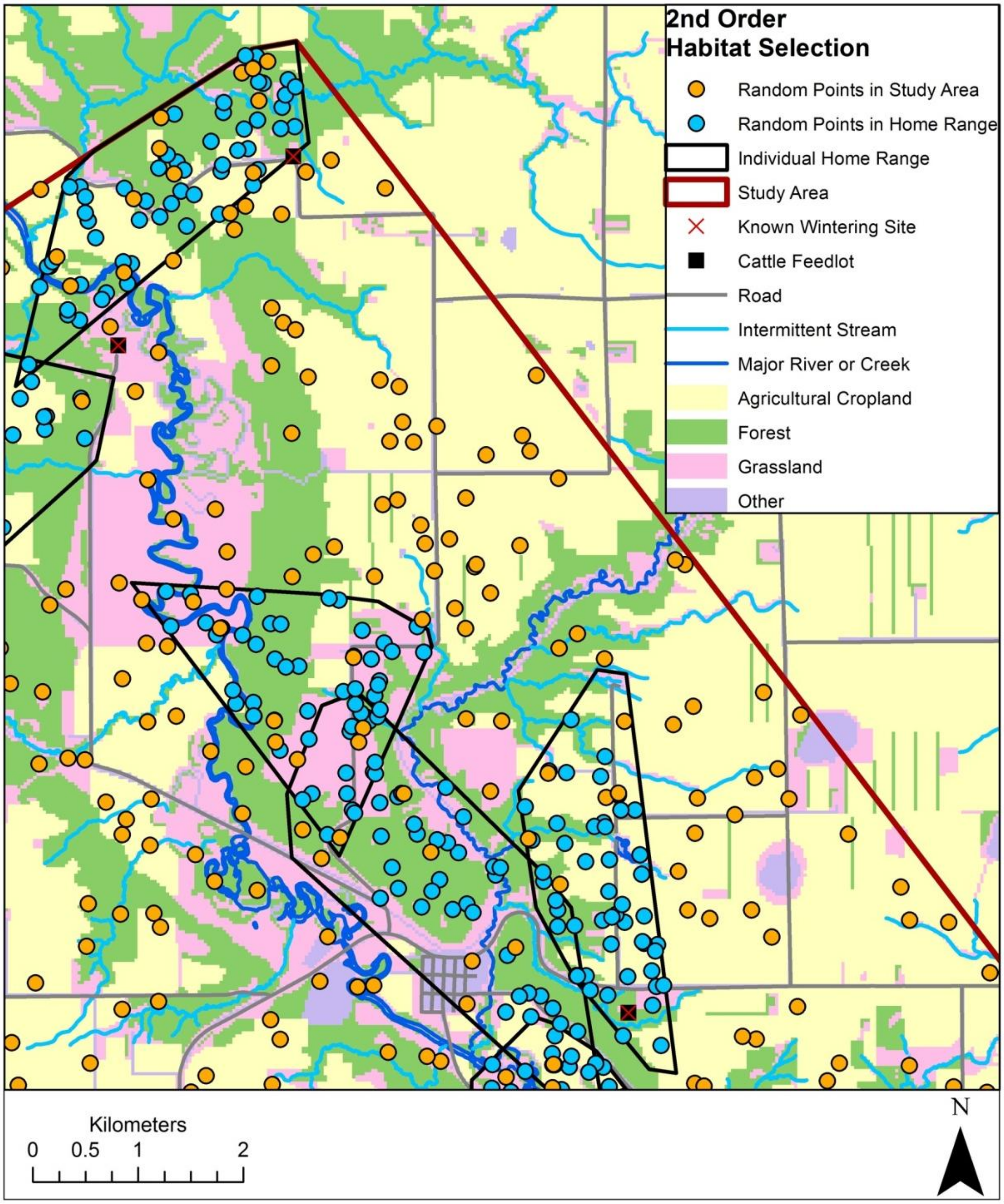
Appendix 8: Spring dispersal observed during 2012, by radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.



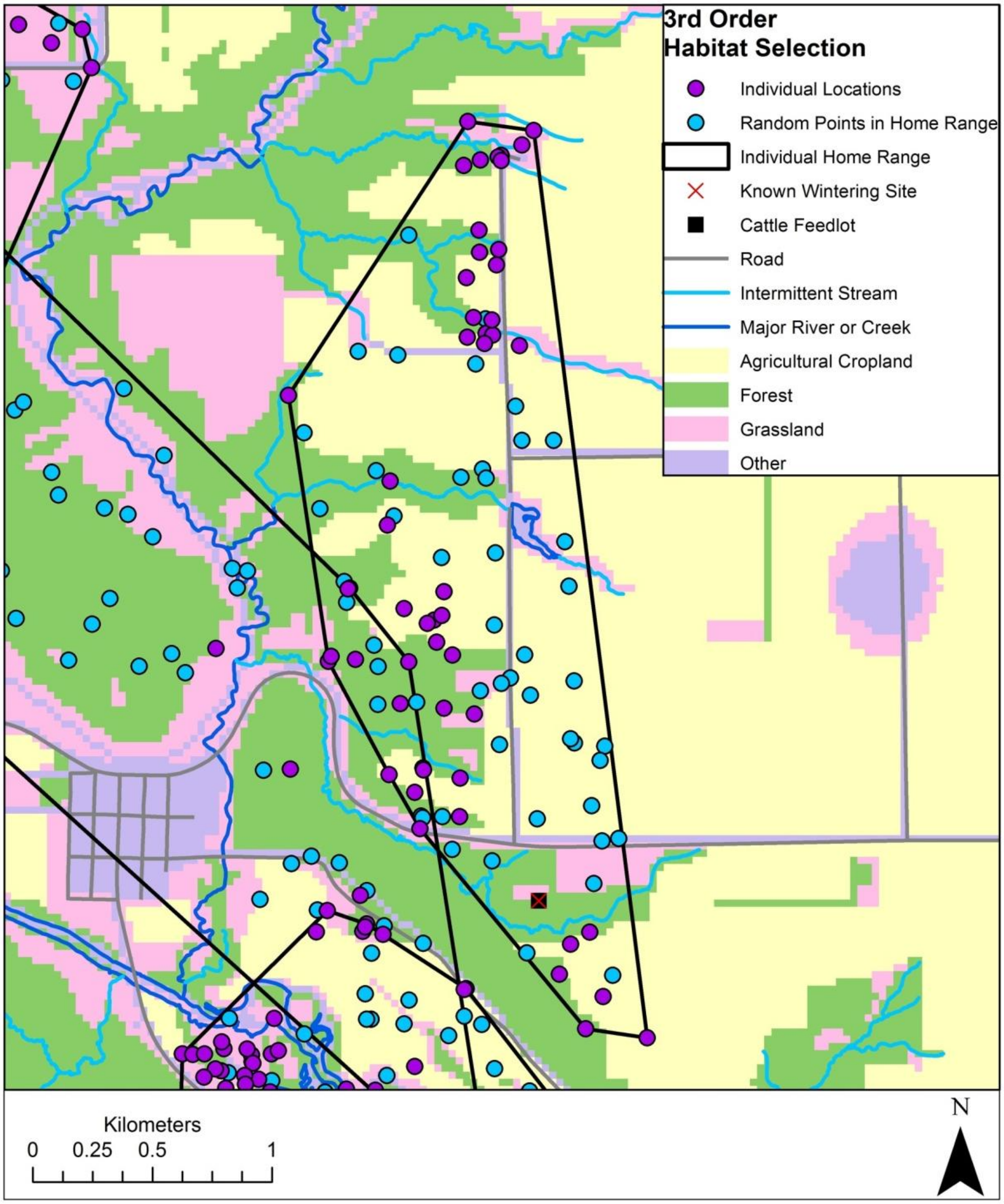
Appendix 9: Minimum convex polygon (MCP) home ranges calculated for radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.



Appendix 10: Example of random points in the study area and random points within individual home ranges that were compared in the 2nd order of selection (home range selection within the study area) habitat use analysis for radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.



Appendix 11: Example of random points within individual home ranges and random points and individual locations that were compared in the 3rd order of selection (selection within home ranges) habitat use analysis for radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.



Appendix 12: Distance ratios (*d*) calculated during the 2nd order of selection (home range selection within the study area) habitat use analysis for radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.

Hen ID	Number of Locations	Cattle Feedlots	Known Wintering Sites	Roads	Major Rivers and Creeks	Intermittent Streams	Agricultural Cropland	Forests	Grasslands
2011_140	47	0.30	0.16	0.62	0.59	0.42	0.48	0.48	0.29
2011_170	53	0.52	1.31	1.41	0.79	0.79	1.39	0.42	0.73
2011_211	56	0.55	0.99	0.63	0.83	0.65	2.74	0.26	0.73
2011_230	55	0.51	0.93	1.60	0.75	0.99	1.09	1.31	0.61
2011_332	51	0.33	1.48	1.17	0.37	0.95	0.70	0.60	0.19
2011_342	60	0.44	1.06	1.43	0.50	0.51	0.88	0.44	0.62
2011_350	59	0.54	0.67	0.66	0.76	0.29	1.20	0.20	0.54
2011_421	50	1.43	0.95	0.86	0.29	0.72	3.02	0.20	0.23
2011_501	51	0.55	1.41	1.12	0.40	1.04	1.30	0.47	0.52
2012_062	45	0.49	1.00	0.74	0.91	0.28	1.71	0.10	0.67
2012_072	51	0.41	0.64	0.78	1.33	0.46	1.41	0.37	0.77
2012_101	42	0.31	0.26	1.87	0.22	0.89	1.39	0.28	0.40
2012_140	46	0.39	1.30	0.66	1.36	0.57	0.70	0.28	0.27
2012_190	51	0.56	0.34	0.48	0.14	0.60	0.70	0.23	0.30
2012_211	52	0.45	0.55	1.15	1.09	0.83	0.75	1.35	1.04
2012_342	43	0.81	0.54	0.77	0.25	1.00	5.35	0.15	0.42
2012_350	47	0.36	1.44	1.35	0.33	0.90	0.77	0.56	0.40
2012_432	57	0.33	0.19	0.85	0.63	0.75	0.91	0.19	0.83
2012_521	48	0.49	0.27	0.35	0.46	0.37	0.15	0.64	0.94
2012_562	42	0.38	1.09	0.59	0.50	0.72	1.41	0.36	0.64
2012_591	48	0.58	1.55	1.73	0.38	0.92	2.55	0.51	0.28
Average	**50.2**	**0.51**	**0.86**	**0.99**	**0.61**	**0.70**	**1.46**	**0.45**	**0.54**

Appendix 13: Distance ratios (*d*) calculated during the 3rd order of selection (selection within home ranges) habitat use analysis for radio-marked female wild turkeys in the Pembina Valley sub-population of southern Manitoba that were monitored during spring/summer (April 18 – September 1) 2011 & 2012.

Hen ID	Number of Locations	Cattle Feedlots	Known Wintering Sites	Roads	Major Rivers and Creeks	Intermittent Streams	Agricultural Cropland	Forests	Grasslands
2011_140	47	1.13	1.14	1.45	0.98	1.09	1.66	0.49	1.23
2011_170	53	0.60	0.97	0.80	1.18	0.75	1.29	0.75	0.49
2011_211	56	0.89	0.93	1.32	0.98	0.96	1.22	0.59	0.91
2011_230	55	0.78	1.15	1.07	1.19	0.43	1.87	0.28	0.47
2011_332	51	0.81	0.96	0.74	1.25	1.00	0.97	1.04	0.93
2011_342	60	1.05	0.91	0.91	0.91	0.73	1.60	0.72	0.54
2011_350	59	0.79	0.88	0.91	1.20	0.78	0.96	0.26	0.96
2011_421	50	1.02	1.02	0.33	1.93	1.10	0.84	1.75	0.53
2011_501	51	1.04	1.07	0.85	1.58	0.59	2.13	0.31	1.48
2012_062	45	0.89	1.00	0.69	1.05	0.97	1.14	3.53	0.30
2012_072	51	0.69	0.97	0.75	0.96	0.97	1.94	0.43	0.37
2012_101	42	0.78	0.71	0.88	1.07	1.34	0.42	1.82	0.72
2012_140	46	1.37	1.02	0.92	1.17	0.73	1.09	0.86	1.50
2012_190	51	0.96	0.96	0.81	0.90	0.98	1.31	0.70	0.63
2012_211	52	0.92	1.03	1.01	0.90	0.93	1.78	0.24	0.66
2012_342	43	1.49	1.49	0.50	1.69	1.18	1.58	0.60	0.73
2012_350	47	1.22	0.94	1.34	0.71	1.24	1.48	0.51	0.40
2012_432	57	1.00	1.00	1.13	1.49	0.60	1.64	0.44	0.93
2012_521	48	1.42	1.42	0.92	1.18	0.69	0.98	0.26	1.08
2012_562	42	1.14	1.08	1.34	1.21	0.83	1.36	0.17	1.15
2012_591	48	0.77	0.90	0.98	0.75	1.13	0.62	0.88	0.45
Average	**50.2**	**0.99**	**1.03**	**0.94**	**1.16**	**0.91**	**1.33**	**0.79**	**0.78**