

Using landowner knowledge and field captures to determine habitat use by the  
northern prairie skink (*Plestiodon septentrionalis*) on exurban residential land  
in southwestern Manitoba

by

Allison Krause Danielsen

A Thesis submitted to the Faculty of Graduate Studies of  
The University of Manitoba  
in partial fulfilment of the requirements of the degree of

MASTER OF NATURAL RESOURCES MANAGEMENT

Natural Resources Institute  
University of Manitoba  
Winnipeg

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## **ABSTRACT**

Exurban development, consisting of low density residential housing in a rural setting, is steadily increasing in North America. This increase may have negative impacts on the habitat for some species, through the introduction of non-native plants and new predators such as house cats. The northern prairie skink (*Plestiodon septentrionalis*) is listed as Endangered in Canada occurring only in southwestern Manitoba. The objectives of this study included: a) defining prairie skink microhabitat use on private land according to vegetation, temperature and cover availability, b) determining landowner awareness of prairie skinks on their property, and c) determining how landowner stewardship could be used in skink conservation. Mixed methods strategy of inquiry was utilized and data collection procedures included both quantitative habitat surveys and qualitative landowner interviews. I found that prairie skinks were most often found in prairie habitat, and were found most often in areas with a) high percent artificial cover, b) high leaf litter, and c) more pieces of cover per acre. Landowners most often saw skinks near buildings, in flower beds and in debris piles. Landowner attitudes towards skinks were positive, though willingness may not translate into action.

## **ACKNOWLEDGEMENTS**

I acknowledge Sustainable Development Innovations Fund (Manitoba Conservation), Manitoba Habitat Heritage Corporation, Habitat Stewardship Fund (Environment Canada) and Natural Resources Institute (University of Manitoba) for funding my project.

I thank my supervisors Pamela Rutherford and Nicola Koper and my committee members Ryan Brook and Iain Davidson-Hunt for their advice and support. I thank Will and Shane for their field assistance.

I thank Larry and Kelly Eagle, Rosalie Sigurdson, Loralie Mitchell, Bill King, Don and Ardythe McMaster, Mark Perry, Paul Dyck, and Tracy and Garnet Hodges for allowing me to conduct skink surveys on their properties. I also thank all the other landowners who participated in my interviews. My project would have never existed without all of you. Your friendliness and hospitality made the project a joy to complete.

I thank Del and Shirley Friesen and Madelyn and Quinton Robinson for providing a roof over my head and food in my belly while I was conducting fieldwork.

I also thank my brother, Tyler Krause, for helping me with field setup logistics, and my dad, Clarence Krause, for helping me with SAS and JMP as well as providing moral support. My husband Chris also has my gratitude for his patience and support through the whole three year process.

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## CHAPTER 1. INTRODUCTION

### Background

With human population numbers reaching 7 billion in 2011, the impacts of human activities are widespread. Humans have changed global land-cover through removal and fragmentation of habitat, the expansion of intensive agriculture, and depletion of soil nutrients (Ojima et al. 1994). The changes caused by humanity are so striking that some suggest we should incorporate “humanized” landscapes into existing land use and protected area definitions (Locke and Dearden 2005). This is particularly relevant because many of the areas inhabited by large populations of people are also biodiversity hotspots, which creates conflict between biodiversity preservation and expansion of human development (Hoekstra et al. 2005). Biodiversity loss not only results in extinction of species but some fear it may lead to in the reduction in the ability of earth's ecosystems to provide the necessary life-giving functions like food production (Foley et al. 2005). In North America, many changes have occurred in the last 200 years, such as the removal of megafauna like bison, suppression of wildfires, and use of rich prairie soils for agriculture (Samson et al. 2004). These changes in land-use have led to a decline in many plant communities, particularly tallgrass and mixed-grass prairies, resulting in a decline of many other species that use those habitats.

The northern prairie skink (*Plestiodon septentrionalis*, formerly *Eumeces septentrionalis*) is a small, semi-fossorial lizard is found in mixed-grass prairie habitat with sandy soils (Bredin 1989, Scott 2005). Its range extends into the northern United States but in Canada, the species only occurs in a very small area in southwestern

Manitoba, which is disjunct from other populations (Bredin 1989). Its habitat has been surveyed extensively in Spruce Woods Provincial Park and on the CFB Shilo military base (Bredin 1981; Bredin 1989, Larkin 2011), but its distribution on private land is not known. It is diurnal and insectivorous, and is active from late April to mid-September in Manitoba (Bredin 1989). Many of the known current populations occur in areas with large amounts of artificial cover (debris piles, plywood, scrap metal), which is used for nesting and protection (Bredin 1999).

Exurban development is defined as low density, residential development in a rural setting (Gocmen 2009). Pockets of exurban development exist within the prairie skink's range and these areas are not as likely to be turned into cropland, as is the case for larger tracts of surrounding land. It may be more plausible to engage landowners in stewardship activities on exurban land than agricultural land because the landowners are not using the land to earn their livelihood, which may reduce the likelihood of conflict. Although many landowners move to exurban residential areas to be closer to nature, some researchers feel that increased urban development may not be good for conservation (Theobald et al. 2005). Some of the negative impacts of exurban development include changes in vegetation, introduction of new predators and increases in anthropogenic disturbance (Audsley et al. 2006; Merenlender et al. 2009). Threats to the prairie skink include changes in vegetation and predation by house cats. Despite changes in land-use, residential areas may still provide appropriate habitat for prairie skinks and, therefore, may be of conservation value. Studies on the prairie skink have yet to examine the role of exurban land as suitable habitat.

Landowner stewardship activities are encouraged by the federal and provincial governments and have led to the creation of the Save Our Skink website by a local biologist, which provides information on prairie skink life history and habitat requirements to the general public as well as encourages citizens to submit sightings (Save Our Skinks 2009). A few landowners have been responsive to this information and have reported prairie skink sightings through the website and through events at Spruce Woods Provincial Park. While infrequent, these sightings provide useful preliminary information about prairie skink populations on private land.

In 2004, the prairie skink was ranked as Endangered in Canada by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and is listed under the federal Species at Risk Act (COSEWIC 2004). The Canadian Species at Risk Act (SARA), enacted in 2002, protects species and habitat on federal lands only. Even so, under SARA, there is a legal requirement to assemble a recovery team and establish a recovery strategy for every species listed (SARA Public Registry 2009). The recovery team for the prairie skink is composed of stakeholders from the provincial government, various NGOs, universities and federal government agencies. Under this recovery legislation, there is a requirement to establish “critical habitat” parameters for every listed species and work is underway to define critical habitat for the prairie skink (Prairie Skink Recovery Team 2006). Critical habitat is not legally defined on private land, but learning more about prairie skink habitat on exurban land will increase the depth of knowledge about the types of habitats prairie skinks inhabit. The provincial Wildlife Act protects prairie skinks from possession by humans but it does not protect prairie skink habitat on

private land (COSEWIC 2004). The prairie skink is not currently protected under the Manitoba Endangered Species Act (MB ESA). This Act protects the habitat of listed species and makes habitat destruction a chargeable offence.

### **Research Purpose and Objectives**

The purpose of my research was to determine how to effectively conserve the prairie skink, as part of a broader effort to preserve mixed-grass prairie habitat on privately owned properties in southwestern Manitoba. My research objectives included: a) defining prairie skink microhabitat use on private land according to vegetation, temperature and cover availability, b) determining landowner awareness of prairie skinks on their property, and c) determining how landowner stewardship could be employed in prairie skink conservation. My objectives were separated into two areas of inquiry: ecology and stewardship.

The ecological aspect of the study involved detailed quantitative characterization of prairie skink habitat. I hypothesized that prairie skinks choose microhabitats based on thermal profile and cover availability. If maximum and minimum microhabitat temperature is moderated by vegetation structure and/or cover, then I expected to find prairie skinks using specific habitats that can provide them with optimal temperatures. If areas devoid of cover have larger variation in temperature, I expected to find fewer prairie skinks using areas lacking cover (either artificial or natural).

The stewardship aspect of this project aimed to discern landowner awareness of prairie skink presence on private properties within the prairie skink's geographical range. Land use, yard maintenance and presence of anthropogenic debris may all impact the

viability of prairie skink populations on small exurban acreages in southwestern Manitoba. The main purpose of this part of the study was to gain preliminary knowledge of landowner awareness of prairie skinks, and the prevalence of land use practices that may affect prairie skinks and their willingness to make changes that could benefit and protect prairie skinks.

To gain the full benefit of the data collected, it is important that the two aspects of this project are integrated in a meaningful way. I achieved this by addressing three integrated and overarching research questions. Firstly, is there suitable habitat available on exurban private land in the area (i.e. debris piles, native vegetation etc)? Secondly, what land use practices on private land are compatible with prairie skink populations, and what threats are present? Finally, how might landowners be involved in prairie skink conservation?

## **Rationale**

Studies on prairie skinks in Manitoba were few until 2005. Until that time very little was known about the prairie skink. However, they are now a priority species for national funding agencies like the Habitat Stewardship Fund (HSP), and they are found in mixed-grass prairie habitat, which is a priority habitat for organizations like Manitoba Habitat Heritage Corporation (funded by HSP) and Nature Conservancy of Canada (Tim Sopuck pers. comm. 2009; Nature Conservancy of Canada 2009). Mixed-grass prairie habitat has been declining, but a large amount of the remaining habitat is on private land and is used for cattle grazing (Samson et al. 2004). However, some of this pasture land is still vulnerable to conversion cropland, such as potato farmland, especially in the

Carberry region (COSEWIC 2004). Until now, most prairie skink research has focused on small areas of suitable habitat on provincial and federal crown land (Bredin 1981; Bredin 1989, Larkin 2011).

The prairie skink recovery strategy also requires that landowners are engaged, because the threat of habitat loss is highest on privately owned land (Prairie Skink Recovery Team 2006). Other species at risk surveys on private land, such as the rare plant surveys conducted by the Manitoba Conservation Data Centre, often focus on locating and mapping a particular species (Manitoba Conservation 2012). This approach is effective for delineating where a species occurs, but does not provide any insight into the probability of success for conservation of that species on private land, nor does it allow landowners to be a part of the process beyond granting permission to access the property. Landowners need to be involved in the conservation process in order for it to be effective, but there is little information in the literature regarding landowner involvement in species at risk conservation. Furthermore, long-term conservation requires landowner co-operation and compatible land-uses but many landowners may not be aware that they have a species at risk on their land.

My research also addressed some of the potential issues and benefits of exurban development for prairie skink conservation. Often people who move from the suburban and urban areas regard exurban developments as environmentally friendly, but because they are not necessarily living off the land, they may lack ecological knowledge which would enable them to see the potential impact of their activities (Gocmen 2009). However, their interest in living in a natural setting might mean that some exurban

landowners are open to learning about the rare species found on their properties (Gocmen 2009). This concept was useful for my research on the prairie skink, because exurban rural landowners were receptive to learning about prairie skink conservation.

In rural southern Manitoba, privately owned yard sites are often consist of manicured lawn, and native species are often replaced with non-native vegetation. In the case of prairie skinks, native vegetation may be important but the particular plant species may not be the limiting factor for prairie skink survival. Prairie skinks use areas with leafy spurge (*Euphorbia esula*), a noxious weed found commonly in the area (Larkin 2011). There is also anecdotal evidence that they also make use of flower beds, gardens and compost piles as nesting spots (Scott 2005). Often, the bigger issue for lizard species is lack of cover and appropriate vegetation structure (Garden et al. 2007). Given that prairie skinks require sufficient cover, and have been found by landowners in wood or debris piles on private property, manicured yards are likely not ideal prairie skink habitat.

Conservation efforts for the prairie skink, therefore, may need to focus on education, by increasing landowner awareness of how the prairie skink might or might not be able to co-exist with humans. If they are aware of the potential habitat debris provides, the landowners may be more content to leave at least some debris on their yard, or alternatively, to landscape in such a way that cover is retained. Heterogeneous habitat consisting of shrubs, forest, and open lawn on private land, in combination with suitable cover, may provide ideal thermal habitat for prairie skinks.

## **Methods**

Over the last 20 years, several paradigms have emerged as dominant within the



social sciences, including post-positivism, constructivism, participation/advocacy, and pragmatism (Creswell 2009). All of these worldviews have a different positionality in relation to how research is conducted within social systems and how reality is defined. The two main streams of social science research have focused on either a reality that must be constructed subjectively by individuals (constructivism), or a reality that is objective and must be measured by the researcher (post-positivism/positivism) (Morgan 2007). The two views of reality often clash in the real world of research (Bergman 2007; Morgan 2007), which then begs the question: is there a way to bridge this gap? One possible answer is pragmatism.

The pragmatic researcher does not focus on one view of reality and the limited research tools available to study a problem from that perspective (Feilzer 2009). Instead, the research starts with a research question and then utilizes any available tools to answer the question (Cresswell 2009). The aim of pragmatism is solving real world, practical research problem (Feilzer 2009). The emphasis of the pragmatic research can be on joint efforts between different disciplines. By sharing an understanding of the research problem, the researchers can connect theory and methods (Morgan 2007). The pragmatic researcher can also find value in many types of data gathering methods. For example, a pragmatic researcher might look at a structured interview and find value in the additional qualitative responses to some of the questions, whereas the positivist may disregard these responses (Feilzer 2009). The most important aspect of pragmatic research is that knowledge is not acquired for its own sake but for a specific purpose, which then justifies the use of mixed methods to achieve the purpose (Morgan 2007).

In terms of my thesis research, a pragmatic worldview is the most appropriate. My research question of how to conserve prairie skinks on private land is a topic that cannot be answered solely with a positivist research paradigm. Conservation and the management of species at risk on private land is a complex issue requiring more than one type of data. Landowners are in control of how their land is managed, and they have information about their own land that is useful to conservation biologists and land managers. At the same time, prairie skinks have biological requirements that must be met so they can thrive on private land. However, these two aspects of prairie skink conservation are not mutually exclusive. In fact, incorporating them both into the same study provides a much richer picture of the conservation and management possibilities. The main problem with incorporating both into the same study is that they require two seemingly opposing strategies of enquiry: qualitative versus quantitative. Until recently, the rift between these two strategies was too large to bridge (Morgan 2007). However, in the last few years, a third strategy has emerged, stemming from the pragmatic worldview: mixed methods.

In the past, it seemed to be sufficient to study the biological aspects of the natural environment on their own, using quantitative methods. However, many researchers and practitioners in environmental science have come to the realization that humans must be incorporated into the study of nature, especially in the field of conservation (Robertson and Hull 2003). To integrate the two, it is advantageous to use both qualitative and quantitative methods. In the case of biology, where quantitative methods are the norm, qualitative data will strengthen the management side of conservation biology by

incorporating a human context and providing an opportunity to engage communities. Tashakkori and Creswell (2008) noted that mixed methods are more easily embraced by practical disciplines (such as natural resource management), because pragmatic researchers are amenable to practical research strategies. This mixing of methods is a new and growing concept in the social sciences, but is less common in natural sciences, though the use of local ecological knowledge has been slowly increasing (Brook and McLachlan 2008). However some of the lessons learned in social science can be transferred over to pragmatic, trans-disciplinary projects in natural science.

One of the major challenges faced by researchers who use mixed methods is how to integrate the qualitative and quantitative data in their analysis and discussion (Bryman 2007). This issue may be exacerbated by the fact that my research not only has qualitative and quantitative methods, but also overlaps fields of biology and social science. Often mixed methods research ends up splitting into two separate streams, with one set of research questions focusing on qualitative and other set on quantitative (Bryman 2007). This is especially difficult in my study, where the objectives are distinctly associated with either prairie skink ecology, or landowner stewardship. Bryman (2007) outlines nine potential barriers to integrating data in social science mixed methods research. Several are applicable to my research including: method preferences of the researcher (i.e. is one side, qualitative or quantitative, emphasized more than the other?), structure of the project (i.e. funding sources prefer one or the other), skill specialization, nature of the data (i.e. one side more interesting than the other), and publication issues.

As a pragmatist, I see the value in the qualitative data I collected from

landowners. Semi-structured interviews consisting of both closed- and open-ended questions provided the most valuable insight into landowner views because landowner responses were not limited to varying degrees of agreement or disagreement, thereby increasing the depth of information gathered. Including both types of questions also allows the researcher to check the consistency of responses (Raymond and Olive 2008). By asking landowners questions about their activities and land uses, I was able to draw parallels to sites with known prairie skink habitat that has been quantitatively characterized. My funding agencies are not a barrier to my research, in fact they encourage the collection of both biological and landowner stewardship data. The addition of qualitative data may also provide additional publication opportunities. Finally, the nature of the data is such that I find both aspects equally interesting and am not tempted to emphasize one type over the other.

I used a concurrent mixed methods approach to my research. As a result, neither of the data sets were used to inform the collection of other data, as they would in sequential mixed methods. The main strategy of inquiry was quantitative, i.e. prairie skink population surveys. However, qualitative data were also collected from landowners and provided a broader scope and context for the surveys. Mixed methods provided more complete information by including not only new information on prairie skink habitat use, but also information on the willingness of landowners to participate in prairie stewardship activities. In the quantitative skinks surveys direct data were collected about prairie skink habitat use, while indirect data were collected during the qualitative landowner interviews (Figure 1).

The most effective way to survey prairie skinks was first to locate appropriate habitat i.e. sandy soil and open grassland, and then to conduct visual encounter surveys which include checking under cover material such as cover boards and other debris (Crump and Scott 1994). It is very time-consuming to search an area for prairie skinks as they are cryptic. Therefore, most surveys to date have occurred in a very small area in proportion to the prairie skink habitat available in the entire geographic range of the species. Landowner interviews were conducted on more properties than the prairie skink surveys. Semi-structured interviews were used because of the exploratory nature of this part of the study. TAMS analyzer was then used to code the interviews and extract information regarding skinks. Once analyzed, the qualitative and quantitative data were then examined together and, in some cases, gaps in one data set were complemented by new information from the other.

### **Organization of This Thesis**

This document follows the format of a sandwich thesis. In this format, Chapter two is a review of relevant literature, while the main thesis chapters are stand-alone manuscripts (Chapters 3 and 4). Each manuscript contains its own introduction, methods, results, discussion and conclusion. Therefore, there is no methods chapter summarizing the methods used. Chapter 3 covers the prairie skink surveys and habitat data collection, analysis and conclusions, while Chapter 4 discusses the interview data. The final chapter integrates the results of chapters 3 and 4 and provides recommendations for management of prairie skinks on private land.

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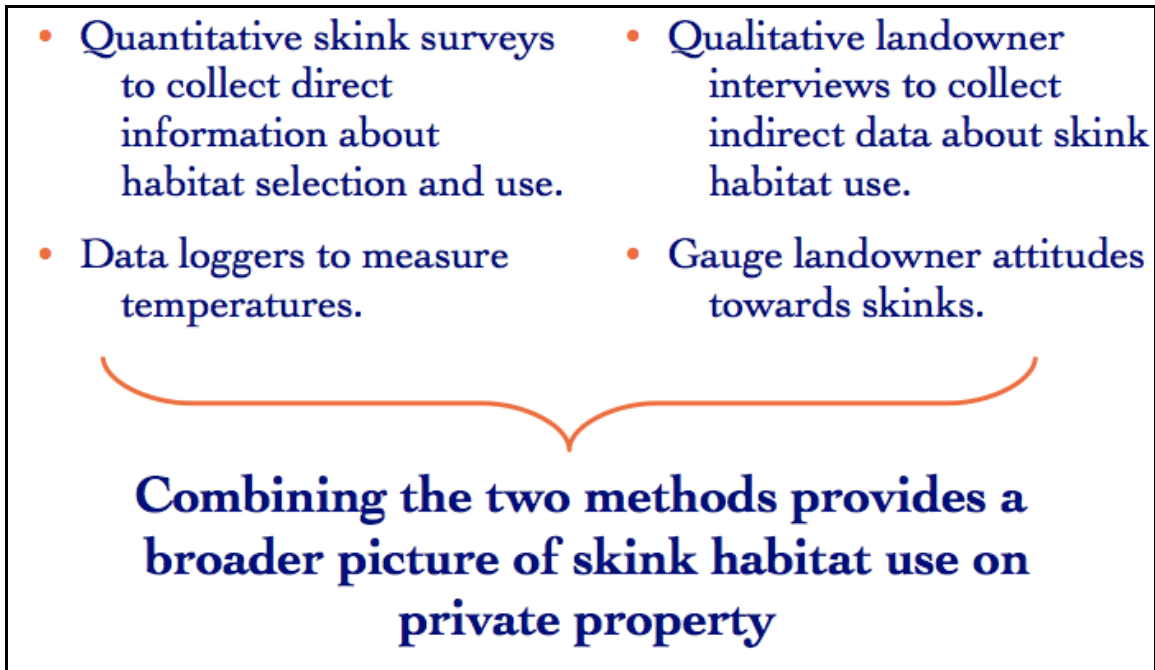


Figure 1. Illustration of the value of using concurrent mixed methods in the collection of broad scale data.

## **CHAPTER 2. LITERATURE REVIEW**

### **Exurban Landowners and Conservation**

#### *Land-use Change and Biodiversity Conservation*

Wherever humans exist, fundamental changes occur to the landscape around them. Forestry and intensive agriculture have led to the removal and fragmentation of habitats, and the depletion of soil nutrients (Ojima et al. 1994). In many cases traditional protected areas may not be enough to protect these habitats, and some have suggested that a new paradigm should be developed that incorporates human impacts into the current land-use categories (Locke and Dearden 2005). Furthermore, the areas with highest diversity, on a global scale, are often the places with the highest concentrations of human populations (Hoekstra et al. 2005). Changes in habitat and loss of biodiversity impact species within the ecosystem and ecosystem services upon which humans rely (Foley et al. 2005). In North America, prairie habitats are among the most heavily impacted ecosystems. Not only has much of the prairie been removed and replaced with cropland, but processes such as fire and bison grazing no longer occur in remaining prairie habitat (Samson et al. 2004). Without these processes, remaining prairie fragments are not self-sustaining. All of these changes in land-use have led to a decline in many plant communities, particularly tallgrass and mixed-grass prairies, resulting in a decline of many species that use those habitats.

#### *Private Land and Species at Risk Conservation*

A key limiting factor in the conservation of Species at Risk (SAR) in Canada is

the lack of involvement of private landowners. In a review of the literature, no research was found that considered landowner response to SAR on their land in Canada. There is considerable literature on the American Endangered Species Act (ESA) in the United States and its implications for private landowners (Brook et al. 2003; Hansen et al. 2005; Raymond and Olive 2008). Unlike the Canadian Species at Risk Act (SARA), the American ESA includes a provision for protecting critical habitat on private land, and, therefore, there are more conflicts with the general public over species at risk issues (Brook et al. 2003). One case study, in Indiana, examined how landowners valued the presence of an endangered species, the Indiana bat (*Myotis sodalis*) (Raymond and Olive 2008). The landowners were situated in a Conservation Management Area, where much of the land was owned by a private organization and was dedicated to conservation. Many of the landowners felt that conservation of the species was important in general, but that the presence of the bat was not necessarily affecting the management of their land. Others were willing to be involved in conservation activities but were never informed as to what they could do. Based on preliminary work, landowners in Manitoba are either neutral or fairly enthusiastic about prairie skinks living on their properties, though some landowners are likely not aware of the cryptic lizards (Krause Danielsen pers. obs.).

#### *Exurban Development and Conservation*

Land use also has major implications for conservation. Although southern Manitoba is dominated by agriculture, many of the residential areas within the range of the prairie skink consist of small, non-agricultural acreages. These rural residential acreages, termed exurban development, are expanding in many rural areas in the United

States as well as some areas around large urban centres in Canada (Gilbert et al. 2005; Hansen et al. 2005). There are some subtle variations on the definition of exurban development. Merenlender et al. (2009) define it as the “subdivision of large rural land parcels into smaller ranchettes that rely on private septic systems and (...) wells.” Other studies define it as “low density residential”, when compared to urban or suburban residential development (Gocmen 2009). Conservation and development often collide in exurban development because exurban landowners often want to live in areas with high biodiversity (Hansen et al. 2005). In many cases the desire to live in close proximity to nature outweighs the social, locational, transportation needs that would be more easily satisfied in an urban or suburban area (Gude et al. 2006; Gocmen 2009).

Land use patterns vary greatly on exurban properties. The residence could be a seasonal cottage or it could be occupied year round. The land itself could be used for recreation or small-scale agriculture (e.g. livestock; Merenlender et al. 2009). Regardless of the use, exurban residential developments take up more land than other residential developments and are often located in areas of high biodiversity and natural amenities like protected areas (Gude et al. 2006). The ecological impacts of such developments are rarely taken into account by developers and home buyers (Theobald et al. 2005). Some research suggests that developers could and should use ecological information when planning a new exurban residential development to minimize negative effects on the surrounding natural ecosystems (Theobald et al. 2005). However, there are few studies on the ecological effects of such developments, especially the effects of small scale agriculture and predation effects on smaller animals such as lizards (Audsley et al. 2006).

Some of the effects of exurban development may be gradual and may initially go unnoticed (Merenlender et al. 2009). Some native species may tolerate human activity and disturbance while more sensitive species may be displaced (Merenlender et al. 2009). Habitat available on developed land may also shift from structurally complex landscapes to simpler landscapes lacking in appropriate cover required by reptiles (Garden et al. 2007). Previous landowner sightings suggests that prairie skinks are not sensitive to all human activities, since they do occur on private land, however, the level of development they can tolerate is not yet known (Pamela Rutherford, pers. comm.).

With exurban development, humans bring new plants and new predators, like dogs and cats, and increased anthropogenic disturbance of the natural habitat (Merenlender et al. 2009). Cats can be particularly detrimental to lizard populations and domestic cats will hunt opportunistically even when they are fed by people (Gillies and Clout 2003, Larsen and Henshaw 2001). Where residential areas encroach onto native habitat, cats have more access to diverse native prey and the negative impact of predation increases (Gillies and Clout 2003). One study found that domestic cats will travel 300m during a hunting expedition, but typically only hunt within 100m of a house, often returning to the same locations repeatedly (Larsen and Henshaw 2001).

### *Aesthetics*

Another challenge to overcome in the efforts to conserve species on private land is the aesthetic appeal of the animals themselves. Knight (2007) hypothesized that people may not be as willing to conserve species they find “ugly”, such as bats, snakes and spiders, versus “cute” species like fur seal pups. Although Knight's study was

preliminary, he found that the university students he surveyed were still likely to find conservation value in “ugly” animals despite their aesthetics.

Property aesthetics of exurban yards is another issue related to conservation on private land. In many neighbourhoods, residents adapt their landscaping to conform to the aesthetic of the surrounding neighbourhood (Nassauer et al. 2009). Messy yards could be viewed by neighbours as unacceptable, and the landowners may feel it is necessary to clean them up. Native plants are sometimes equated with messiness in the eyes of neighbours who have more manicured yards. If native vegetation does exist on the property it is often more acceptable to neighbours and aesthetically pleasing if it is framed by tended vegetation like a monoculture lawn (Nassauer 1995). Removal of taller vegetation in favour of short lawns may impact the thermal gradients required by reptiles (Blouin-Demers and Weatherhead 2002). However, many rural yards have debris piles, scrap metal, old vehicles, and wood piles, which may provide essential prairie skink habitat.

### *Local Knowledge and Citizen Science*

Landowners living in a rural setting are closer to the natural world than those living in the city. As a result they often observe natural phenomena and can provide useful information to wildlife managers in the form of Local Ecological Knowledge (LEK). Conservation biologists disagree over the role of LEK in wildlife management (Brook and McLachlan 2005, Gilchrist and Mallory 2007). Some feel that it is only secondary to, and must be verified by, expert-based data (Gilchrist and Mallory 2007), while others feel that it has its own value and can be used to empower communities to

manage and maintain their own land (Brook and McLachlan 2005). Despite the disagreement, LEK has proven useful in bridging knowledge gaps, particularly where expert-based data is lacking and/or difficult to obtain.

In addition to the direct collection of LEK, landowners can be invited to participate in citizen science projects, in which data are collected by the general public following an empirical structure (Copper 2007). Successful programs in Canada, such as PlantWatch and FrogWatch, facilitate collection of localized data by citizens, which is then compiled via a web portal (NatureWatch 2011). These types of projects are initiated by scientists who wish to collect information over a broad timescale and geographic area. Local landowners are typically only involved in the collection of the data and then those data are submitted to the researcher for analysis and result reporting. Some feel that this method is not as effective as it could be, and that projects created from within the community are more successful (Danielsen et al. 2010). Decisions based on the results of community-based projects can be arrived upon more quickly than government-based decisions that are typically prescriptive and are more likely to be implemented on a day to day basis in the community (Danielsen et al. 2010). Some of the potential challenges and limitations of using data collected via citizen science include variation in data quality due to variation in data collection skills, validation of the data, sampling effort variation, and lack of sampling area coverage (Dickinson et al. 2010). Despite these drawbacks, citizen science projects can cover large geographic areas with multiple species and can be used to detect patterns of environmental change over time (Dickinson et al. 2010). Additionally, encouraging people to collect data where they live can foster an interest in

conserving the biodiversity that exists locally and foster a greater enjoyment of backyard biology (Miller and Hobbs 2002). As humans continue to alter and impact the natural world, local people must be increasingly involved in the solutions, if they are to be effective. With citizen science, local stakeholders who become involved in a project (e.g. studying predation of songbirds by cats), are more likely to make small changes that may add up to larger changes across the landscape (Cooper 2007). Combining citizen science with expert science and adaptive management may be a very effective way to manage biodiversity into the future (Cooper 2007). Citizen science will be the next step in encouraging landowner participation in prairie skink conservation activities.



## **Prairie Skink and Temperate Reptile Ecology**

### *Prairie Skink Distribution and Life History*

The prairie skink (*Plestiodon septentrionalis*, formerly *Eumeces septentrionalis*) is found in the Great Plains region of North America. There are two subspecies, northern (*P. s. septentrionalis*) and southern (*P. s. obtusirostris*), which have a combined range extending from southern Manitoba south to Texas (Conant and Collins 1998). The range of the northern subspecies extends from southern Manitoba into northeastern Oklahoma. In Manitoba, the prairie skink population is disjunct from the main population by about 150km (Cook 1964). The species occurs mainly in the Upper Assiniboine Delta and is restricted to mixed grass prairie habitat with sandy soil (Bredin 1993). The majority of the known Manitoba prairie skink population occurs in the area near Carberry (49° 52' N, 99° 21' W), extending to just north of Treherne in the east and to the western edge of the Shilo military base (COSEWIC 2004, Figure 1). There is also a smaller disjunct population in the Lauder Sandhills (49° 23' N, 100° 40' W), located southwest of Brandon, Manitoba.

The prairie skink is a small, diurnal, insectivorous lizard, with adults snout-vent length (SVL) measuring approximately 80-85mm (Bredin 1989, Figure 2). Male prairie skinks develop bright orange colouration on their cheeks and throat during breeding season (Nelson 1963). Neonates average 25mm in length (Breckenridge 1943, Nelson 1963, Bredin 1989). Young of the year are clearly distinguishable by their bright blue tail, which fades when they reach 45mm SVL (Nelson 1963). The brightly coloured tail is

thought to distract predators away from vital body parts, and juveniles will wiggle their tail vigorously to enhance the distraction (Vitt and Cooper 1986). When threatened with predation, both adult and juvenile prairie skinks can detach their tail (tail autotomy), and male prairie skinks may also lose their tails while fighting (Vitt and Cooper 1986). However, Vitt and Cooper (1986) noted that juveniles did not detach their tails immediately when captured, indicating that there may be some cost to unnecessary tail loss.

In Manitoba, adult prairie skinks are most active in spring (May and June), during their breeding season (Scott 2005). Clutches of 4-18 eggs are laid in late June and hatch approximately 30 days later, in early August (Bredin 1989; Nelson 1963; Somma 1987b). Clutch size can vary and is positively correlated with SVL of the female (Somma 1987b). Once the young hatch, females may remain with the neonates for up to two days, exhibiting varying degrees of maternal care, such as licking the young to remove remnants of egg sac (Somma 1987a).

Cover material, such as decaying wood, mats of creeping juniper and also anthropogenic debris such as old tires, wood piles, carpet and scrap metal, all provide essential microhabitat for prairie skinks (Bredin 1989; Nelson 1963). Female prairie skinks nest under natural and artificial cover material, and both adult and juvenile prairie skinks use cover material as protection from predation and extreme temperatures (Bredin 1989; Nelson 1963). Prairie skinks will choose appropriate microhabitats to maintain a body temperature of 22-35°C (Nelson 1963). During the warmer months, ground temperatures can reach 41-44°C, and prairie skinks likely bury into the sand to escape

these lethal temperatures (Nelson 1963). They may even aestivate during hot periods of the summer, similar to other species in the same genus (Fitch 1954).

Predators of the prairie skink include American Kestrels, house cats, and hognose snakes (Bredin 1989; Rutherford et al. 2010). Incidence of predation attempts is presumably high in Minnesota, because the tail loss/regrowth frequency was 77% (Nelson 1963). Prairie skinks are insectivorous and eat mostly spiders and crickets, but will also eat grasshoppers (Bredin 1989). Food availability may be a limiting factor to prairie skink population growth in some disturbed landscapes (Pitt 2001).

### *Reptile Habitat Requirements*

Research conducted on other fossorial reptiles may provide insight into the habitat needs of Manitoba's prairie skink, especially because of the habitat limitations of all northern ectotherms (Blouin-Demers and Weatherhead 2002; Diaz 1997; Quirt et al. 2006). For small reptile species, cover is an important habitat feature. In areas of Point Pelee National Park that are heavily used by people, five-lined skinks (*Plestiodon fasciatus*) colonize artificial cover set out as a replacement for natural cover that had been removed by human activities (Hecnar and M.'Closkey 1998). Artificial rocks were found to reduce the decline of snake populations in Australia while apparently not affecting the quality of the thermal habitat required by the species (Webb and Shine 2000). The five-lined skink also makes use of rock cover in Canadian Shield habitat elsewhere in Ontario, where decaying woody debris is not available (Howes and Lougheed 2004). Western skinks (*Plestiodon skiltonianus*) also rely on rock cover and show site fidelity to certain rocks found in their home range (Rutherford and Gregory, 2003). In addition, five-lined

skinks were found in larger aggregations where total surface area of cover (i.e. decaying wood) was higher (Seburn 1993). Prairie skinks are found on the open prairie with native grasses and low shrubs (Scott 2005), but most known populations are restricted to areas where sufficient cover is available. Dense mats of creeping juniper (*Juniperus horizontalis*) may act as cover for prairie skinks. However, prairie skinks often use artificial cover, like scrap metal and plywood (Bredin 1999).

Cover is crucial for predator avoidance, but it also affects the thermal environment experienced by an individual, which is especially important for ectotherms (Quirt et al. 2006). A thin layer of cover material located in an open sunny area can be used by five-lined skinks to increase their body temperature in the morning while still remaining hidden (Seburn 1993). Some snakes prefer not to bask in the open, but instead choose rocks based on thickness, which provide different thermal environments (Huey et al. 1989; Webb and Shine 1998). The five-lined skink relies heavily on the thermodynamic properties of rocks resting on outcrops of bedrock in the northern Ontario (Quirt et al. 2006).

Temperature is an important component of the habitat conditions of any reptile, as they use external temperature gradients to maintain optimal internal temperatures. Many different factors are important to reptile survival such as food availability, predation risk and reproduction, but temperature influences all of these factors (Diaz 1997; Webb and Shine 1998; Blouin-Demers and Weatherhead 2002). Availability of thermally optimal habitat is likely a limiting factor in northern reptile populations (Blouin-Demers and Weatherhead 2002; Diaz 1997; Quirt et al. 2006). Thicker rocks, which heat and cool

slowly, were used during the hotter months, and thinner rocks were used by snake species in cooler months because they heat up quickly (Huey et al. 1989; Webb and Shine 1998). Other reptiles will modify their behaviour to take advantage of the thermal qualities in the habitat. Diaz (1997) found that higher altitude lizard populations compensated for suboptimal temperatures by using full sun areas more often to maintain an optimal body temperature. This may also be applicable to populations of reptiles at the northern part of their range (Diaz 1997), such as Manitoba's prairie skink population.

Many existing prairie skink populations are also found in edge habitat where mixed grass prairie meets aspen/mixed forest. Blouin-Demers and Weatherhead (2002) found that edges provided superior thermal habitat for the black rat snake, because it provided easy access to both cool habitat in the forest, and warm open areas for basking. Such areas of “high thermal quality” require less effort from the animal to maintain higher temperatures, which are needed for physiological processes such as digestion and gestation (Blouin-Demers and Weatherhead 2002). Additionally, Diaz (1997) found that the combination of shade and rocky cover provided protection from lethally hot temperatures reached under rocks in the open sun.

Vegetation structure, such as low shrubs, provides a mosaic of shade and thermal gradients, which can buffer high temperatures. Prairie skinks in Manitoba are often found in grassland areas with dense creeping juniper (Scott 2005). Vegetation structure is likely more important than the actual plant species present in the habitat, as many reptiles rely on vegetation to provide a mosaic of microhabitat characteristics required to thermoregulate, breed, gestate, and forage (Howes and Lougheed 2004). Prairie skinks

have been found in areas heavily infested with leafy spurge, an invasive plant found in the same geographic region of Manitoba. However, current studies are showing that leafy spurge changes the temperature profile of the habitat and this may negatively impact the prairie skink (Larkin 2011, Pamela Rutherford pers. comm.). They have been observed in areas of non-native vegetation, such as smooth brome (*Bromus inermis*) and kentucky bluegrass (*Poa pratensis*), which suggests that they are more dependant on soil type (A. Krause Danielsen, pers. obs.). The sand skink (*Plestiodon reynoldsi*) in Florida, has been resilient to changes in vegetation cover because its fossorial behaviour allows it to occupy areas with a particular soil type, rather than specific plant species (Pike et al. 2007). Prairie skinks are also highly fossorial and associated closely with sandy soil.

Microhabitat conditions are also important for nesting. Seburn (1993) found that groups of five-lined skinks aggregated in areas with appropriate nesting sites and one female was observed to travel 68m to her nesting site. Additionally, Hecnar (1994), found that females will nest communally at a particular site, and that the sites needed to be higher humidity than the surrounding habitat. However if humidity is too high, the eggs will rot; if it is too low, they will desiccate (Hecnar 1994). Sufficient humidity also allows prairie skinks to grow larger before they hatch, as moisture is absorbed through the soft shell of the egg (Somma 1989). Little is known about the nesting habitats for prairie skinks in Manitoba (COSEWIC 2004).

#### *Prairie Skinks and Exurban Development*

One study in the U.S. on the prairie skink indicated that, despite adequate food and suitable vegetation and soil, they are slow to re-colonize abandoned fields (Pitt

2001). Success of lizards in areas disturbed by human activity may depend on the adaptability of the species itself. Some lizard species in exurban habitat in Arizona benefit from human-made structures like fence posts, while other species preferred undeveloped habitat (Audsley et al. 2006). Germaine and Wakeling (2001) found that some species of lizards could tolerate low density human development, but once a moderate level of urbanization had occurred, and native habitat became more limited, only highly urban-adapted arboreal lizards were abundant. In a national park in Greece, the reptile community appeared to benefit from the habitat heterogeneity created by human activities and development, so long as the activities were not too intensive (Bousbouras 1997). Some activities are more compatible with reptiles than others. For instance, intensive agriculture could be the largest factor negatively impacting lizard diversity in the Mediterranean (Ribeiro et al. 2009).

Although prairie skinks are restricted to habitat with sandy soil, suitable habitat could be available in the context of human development. However, current information regarding the prairie skink on private land in Manitoba is largely anecdotal. Since 2006, prairie skink sightings have been reported by landowners, sometimes in close proximity to development (Pamela Rutherford, pers. comm.). Prairie skink nests have been found in flower beds and compost piles (Rosalie Sigurdson, pers. comm.). Adult and juvenile prairie skinks have been seen in gardens, lawns and even crawling up the sides of buildings (A. Krause Danielsen, unpublished data). Prairie skinks are also commonly observed in debris and wood piles on rural properties (A. Krause Danielsen, unpublished data). When combined with other habitat and capture data, these sightings and

observations can be used inform conservation and land management decisions on private land.



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## Figures

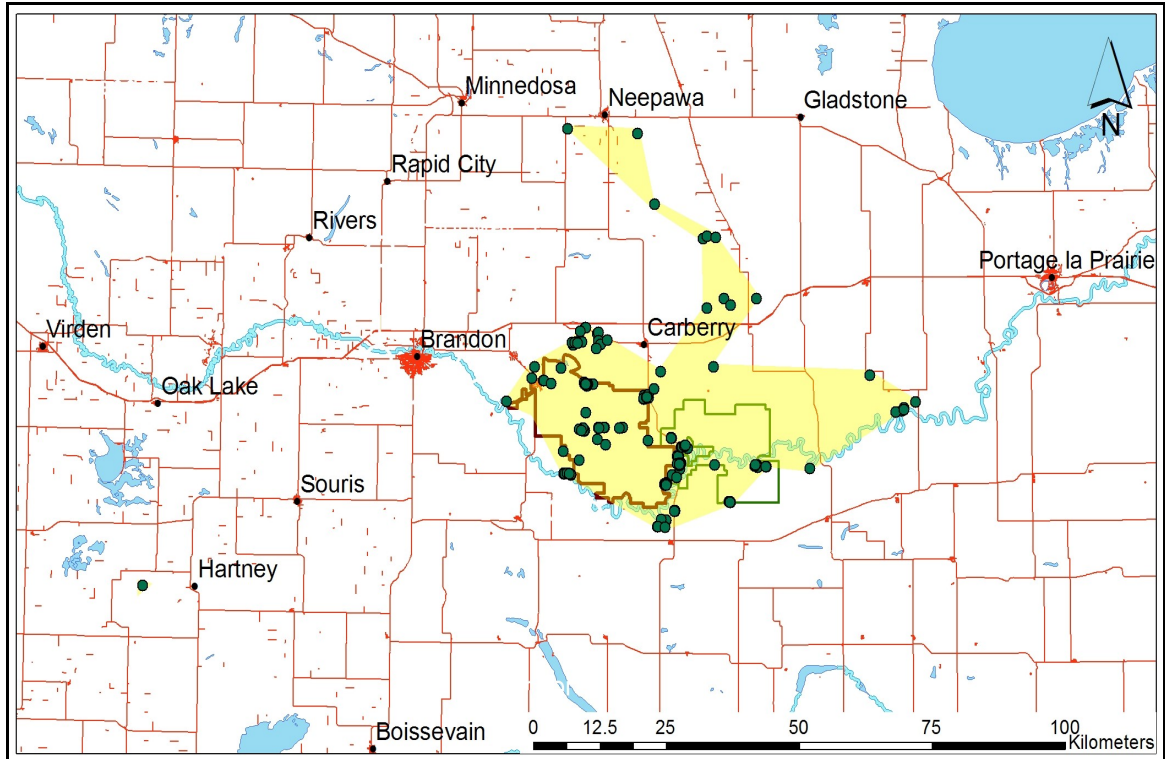


Figure 1. Range of northern prairie skink in southern Manitoba (Rutherford, unpublished. Base layers from Manitoba Land Initiative).



Figure 2. Adult prairie skink, near a piece of artificial cover material.

### **CHAPTER 3. THE IMPORTANCE OF VEGETATION STRUCTURE AND ARTIFICIAL COVER FOR PRAIRIE SKINKS (*PLESTIODON SEPTENTRIONALIS*) ON EXURBAN LAND**

#### **Abstract**

The northern prairie skink (*Plestiodon septentrionalis*) is listed as Endangered under the federal Species at Risk Act. Very little is known about habitat use of this semi-fossorial lizard and much of the research to date has occurred on provincial park lands and federal military lands. This project aimed to define prairie skink habitat characteristics on exurban private land, which is defined as low density rural residential developments, 5 to 20 acres (5 to 8 ha) in size. The management of these properties is highly variable, yet skinks are still observed close to human development. Prairie skink presence data were collected using visual encounter surveys in three habitats types found on eight exurban properties: mowed lawn, gardens/flower beds and native prairie. During the surveys, I searched the entire area of a particular habitat on foot and calculated person/hours of search effort. At each capture site and three other randomly selected sites within 10m of each capture site, I recorded percent cover of grasses, forbs, small shrubs, bare ground, litter and cover material. I also recorded the locations of all cover material within grassland habitat. To measure thermal habitat characteristics, I placed iButton® temperature loggers in each of the three habitat types. Prairie skinks were found most commonly in native prairie and were significantly more likely to be found in areas with more artificial cover material. The number of prairie skink captures increased significantly as cover abundance per acre increased. Vegetation height was the most important factor moderating temperature among the habitat types. Cover may also be



important on properties with minimal heterogeneity in the vegetation structure. Suitable prairie skink habitat exists on exurban land, specifically remnant prairie and an abundance artificial cover material.

## **Introduction**

Historically in North America, conservation activities have focused on protection of lands, often in the form of parks and preserves. Thus, conservation research is conducted most often in these “wild” areas (Cooper et al. 2007). Little conservation-related research is conducted on developed residential lands and these lands are usually considered to be less important for conserving biodiversity (Cooper et al. 2007). When conservation research is conducted outside of preserves, it often occurs in sectors where resources are extracted, such as in forestry (Miller and Hobbs 2002). Despite the lack of research attention given to developed land, human activities have a great impact on biodiversity and therefore areas used heavily by people should be included in conservation research (Cooper et al. 2007). Parks and preserves do not protect enough land to achieve a level of biodiversity conservation to counteract the broader impacts of human development.

Private land is managed very differently from parks and preserves, though the intensity of management is variable. Parks may focus on ecological integrity of particular ecosystems while also providing recreational opportunities (Manitoba Conservation 1998). In contrast, private landowners may or may not be focused on preserving ecological function. The changes associated with urban expansion can bring about changes in habitat that favour generalist species and result in the decline or loss of

specialist species (Blair 1996; Germaine and Wakeling 2001; Merenlender et al. 2009). Introduced predators like cats can damage reptile, bird and small mammal populations (Audsley et al. 2006; Gillies and Clout 2003; Larsen and Henshaw 2001). These changes make it more difficult for some populations of small organisms to thrive on privately owned developed land.

While urban and suburban developments are commonplace, exurban development is becoming more common in North America. Exurban developments are defined as “low density” rural residential developments that occur outside of cities, often in the form of acreages or “ranchettes” (Gocmen 2009; Merenlender et al. 2009). Although there may be small scale agriculture such as horses or a greenhouse, the main function of the property is residential. Accessibility to city amenities through the proliferation of personal vehicles has allowed many people to live in remote areas and still work in cities (Gocmen 2009). This means that many areas that were formerly used for activities like agriculture are now being developed as residential areas. These developments are spread over larger tracts of land than urban areas but the properties are often landscaped and manicured in a similar style to suburban lots because native vegetation is considered to look “messy” (Nassauer et al. 2009). Additionally, many exurban developments can negatively impact the biodiversity of a region as exotic plants and development-adapted animals colonize the area (Hansen et al. 2005). Anthropogenic impacts of private lands can also extend beyond the legal boundaries of the properties, which can be problematic, particularly if those lands are near parks or preserves.

Rare species found in parks may also be found on developed land in the

surrounding area. The northern prairie skink (*Plestiodon septentrionalis*) is a semi-fossorial lizard found in sandy mixed-grass prairie habitat. It is listed as Endangered under the Canadian Species at Risk Act (COSEWIC 2004). Its range in Canada is restricted to the sandy soils of the Upper Assinboine Delta in southwestern Manitoba (Bredin 1989). A portion of the prairie skink's habitat is protected within Spruce Woods Provincial Park, on federal land on Canadian Forces Base (CFB) Shilo and within provincial Wildlife Management Areas (WMAs). The majority of the research on this lizard has focused on these public and federal lands (COSEWIC 2004), despite the fact that there is extensive prairie skink habitat on private land outside the park, the base and the WMAs. Surrounding Spruce Woods Provincial Park and CFB Shilo, there are recent exurban residential developments, with the newest development occurring within the last 5-10 years (Chapter 4, this thesis). People living in these areas do not generally lead an agricultural lifestyle but instead work in nearby towns, on the military base, or in the nearby city of Brandon, and they use their properties mainly as a residence and for recreation. It is unknown whether these exurban developments and the associated activities are compatible with the habitat requirements of the prairie skink.

The prairie skink is a cryptic species. Overall, the species prefers sandy soil because this soil type remains loose enough for the prairie skink to hibernate and make nest burrows (Nelson 1963). In general, prairie skink habitat is composed of a mixed-grass prairie and low shrub mosaic, and cover is likely an important habitat feature, as it is important for related species of semi-fossorial lizards (Hecnar and M'Closkey 1998; Rutherford and Gregory 2003; Scott 2005; Seburn 1993). Prairie skinks often colonize

areas with artificial cover material such as plywood, carpet, linoleum, scrap metal and rail ties (Bredin 1989; Nelson 1963). A closely related lizard species in Ontario, the five-lined skink (*Plestiodon fasciatus*), uses woody debris and leaf litter and has been shown to re-colonize artificial cover in areas where debris had been removed (Hecnar and M'Closkey 1998). Seburn (1993) found that larger numbers of five-lined skinks used areas with higher surface areas of debris.

The importance of cover may be directly related to the daily requirements of prairie skinks. The optimal thermal range for prairie skinks is 22-35°C, but temperatures can reach lethal levels of over 44°C in open prairie (Nelson 1963). Edge habitat, where mixed-grass prairie meets shrubs or forest, can provide more variation in temperature, and therefore more opportunities for optimal thermoregulation (Blouin-Demers and Weatherhead 2002). Variation in vegetation structure in mixed-grass prairie habitat may provide similar heterogeneity. It is suspected that prairie skinks use natural vegetation and artificial cover to escape lethal temperatures, however this remains untested. Some reptile species have been shown to prefer cover materials that provide optimal temperatures (Huey et al 1989; Web and Shine 2000). However, prairie skinks are often found under artificial cover where temperatures are sub-optimal, indicating they may hide under cover material for other reasons, such as predator avoidance. Other lizard species have been shown to hide as predators approach and remain immobile for longer periods of time as predation pressure increases (Cooper 1998). If predation pressure is high, the amount of time spent at sub-optimal temperatures may have negative impacts on fitness of individuals (Downes 2001). Martin (2001) suggests that the safer refuges are often the

least optimal for thermoregulation and therefore reptiles must balance the cost of safety with the need to thermoregulate. Since prairie skinks live in a temperate region with a very short summer in which to grow and reproduce, balancing this trade-off is crucial for over-winter survival and reproduction.

Data from historical surveys and previous landowner sightings suggests that prairie skinks are found on private properties throughout the region where sandy soil is predominant (Manitoba Conservation Data Centre, unpublished data). Debris may play an important role in providing appropriate microhabitat for prairie skinks in areas that have been altered by exurban development because it provides escape from predators and may provide appropriate thermal conditions. The impacts of increasing development on prairie skinks have not been measured, nor has habitat use of prairie skinks on private land been defined. The main objective of this research was to define prairie skink microhabitat use on private land according to vegetation structure, cover availability and thermal habitat characterization. I determined whether prairie skinks were more likely to be found in areas with more artificial cover, and in what types of habitat they were found (i.e. prairie, lawn, or garden). At a landscape scale, I predicted that prairie skinks would be more likely to be found in higher numbers on properties with more cover. At a local scale, I predicted that prairie skinks were more likely to use open habitat that was near artificial cover material, compared to open habitat that was far from cover. Within the habitat available, I determined which features were most important for habitat selection by the prairie skink and whether vegetation and cover structure were more important than specific vegetation classes. Lastly I determined how habitat characteristics affected

thermal habitat and which types of habitat could provide optimal thermal habitat for skinks. I predicted that daily temperatures would vary more in lawn than prairie and less in garden than prairie.

## **Methods**

### *Study Area*

The study area ranged between Highways 1 and 2, extending west to the town of Shilo (49° 48' N, 99° 38' W) and to just east of Lavenham, Manitoba (49° 47' N, 98° 43' W) (Figure 1). Prairie skink surveys were conducted on eight ( $n=8$ ) properties distributed across the entire study area. Private land in these areas consisted mainly of small acreages (0.8 to 12 ha), which had not been converted to cropland. All the study properties were located within the prairie skink's range in Manitoba, which is restricted to the Upper Assiniboine Delta and characterized by sandy soil, mixed grass prairie and mixed forest (Bredin 1989). The climate conditions in the area were characterized by hot, wet summers and cold dry winters. Generally, the average maximum temperature in summer is 25°C and the average minimum temperature in January is -23°C, while precipitation averages 472 mm annually (Environment Canada 2011, Brandon Airport).

### *Prairie Skink Surveys*

Survey sites were determined by previous detections of prairie skinks on the property and willingness of landowners to allow researchers on their land. Habitat on each of the eight properties was categorized into three types: lawn, garden/flower bed, and mixed-grass prairie. These categories reflect habitat types that were available to

prairie skinks, and are commonly found on private land in this region. I surveyed properties bi-weekly from May 13 to August 25, 2010. To minimize biases caused by environmental conditions, I visited the same property at different times of the day and in various weather conditions, although surveys were not conducted if the daily high was below 10°C, or if there was constant precipitation or thundershowers. I visited all properties throughout the summer to control for seasonal changes in prairie skink density.

I conducted walking surveys on each property, following visual encounter survey methods (Crump and Scott 1994). Each habitat type was surveyed systematically by walking in straight lines, approximately 2 m apart, back and forth until that habitat area had been entirely searched. An intermediate searching intensity was used, which included turning over artificial and natural debris including logs, boards, and scrap metal. Habitat was not destroyed during the survey. Survey time was measured in person hours of effort and processing time for captured animals was not included in the search effort time. Once the visual survey was complete, all captured animals were marked with a unique toe clip, measured (snout-vent length, tail length, head width and weight) and released at the location of capture. I also noted breeding colouration of males (orange chin) and juvenile tail colouration (blue). Some animals were seen but not captured, in which case only habitat data were collected for those animals. All research was done in compliance with University of Manitoba Animal Care and Brandon University Animal Care protocols (2006R02-3).

### *Vegetation Structure*

For each prairie skink capture, I recorded the location (UTM co-ordinates) using a

Garmin GPS60 unit. I recorded whether the prairie skink was in the open or under cover and measured percent cover of the vegetation in a 1-m<sup>2</sup> plot at the prairie skink capture site. The habitat and vegetation were classified into the following categories: bare ground, leaf litter, mosses/lichens, grasses, forbs, and low shrubs (<1-m) (modified from Scott 2005). I took photos of these plots for verification purposes (Figure 2). I also characterized vegetation and habitat in three randomly chosen 1-m<sup>2</sup> plots within the same habitat type and within a 10-m radius of the prairie skink capture, which were used to compare selected habitat with available habitat.

I compared the microhabitat scale characteristics at prairie skink capture locations ( $n=59$ ) with those of random locations surrounding the capture site using generalized estimating equations (GEE). GEE is derived from a generalized linear model, however it allows for correlation structures within the data (repeated factors). The analyses were run using PROC Genmod in SAS 9.2, with a binomial response distribution. Prairie skink captures were given a value of 1 and random plots a value of 0. Prairie skink locations (including both the point at which the prairie skink was found and the three random locations) were used as the repeated subject in the analysis because there were three random points associated with each capture site and these four points were correlated with each other. The independent habitat variables included in the analysis were percent cover of grasses, forbs, low shrubs, leaf litter, cover material and bare ground. These variables did not show collinearity and were biologically relevant.

#### *Cover Availability*

To quantify the amount of cover available on the properties I surveyed at a



landscape scale, and recorded UTM co-ordinates for each piece of cover (boards, metal scraps, logs, lumber) in the areas surveyed. Single pieces of cover or two pieces within a metre of each other were marked as a single waypoint because of the precision of the GPS unit. Larger accumulations of multiple pieces of overlapping cover (cover clusters) were documented as a polygons by walking around the debris pile to delineate its boundary. Mixed-grass prairie habitat at each site was digitized using 1:40,000 aerial images from Manitoba Land Initiative (Manitoba Conservation 2011). Two sites lacked high quality orthophotos, so the mixed-grass prairie boundary was mapped using a GPS unit and uploaded to ArcView 9.2 GIS software. The area of each mixed-grass prairie polygon was calculated in acres.

To test my prediction that more prairie skinks will congregate in areas with higher cover at a landscape scale, I created an index of cover availability. The total number of cover clusters and individual pieces of cover were divided by the total area of mixed-grass prairie on each property, to assess cover density per acre. For the response variable, I created a prairie skink capture index, calculated as the number of prairie skinks found in mixed-grass prairie per total person hours of searching over the entire season ( $n=37$  skinks, on 7 of the 8 properties). I used linear regression to determine whether cover density influenced the rate of prairie skink captures. One data point outlier was removed to ensure statistical assumptions could be met. The data were analyzed with and without the outlier, and this did not change the significance of the result.

To test my prediction that prairie skinks in the open would remain near cover material on the local scale, prairie skink capture locations and debris locations were

inputted into ArcView 9.2 GIS software and a 10-m buffer layer was applied to the point layer. The number of prairie skinks captured in the open within the 10-m buffer was counted. Ten random points were selected within each mixed-grass prairie polygon and the number of those points found within the buffer was also counted. Prairie skink captures were then compared to the random points using GEE.

### *Thermal Habitat Characterization*

iButton® data loggers were used to log hourly temperature data continuously from June 2 to August 4, 2010 at three of the eight survey sites. Data loggers were placed on properties containing mixed-grass prairie, lawn and garden habitats. The iButtons® were wrapped in a small piece of tulle, placed in 10 cm piece of copper tube, were then stoppered and wrapped in duct tape (Figure 3). Copper tubing has commonly been used as an analogue of thermoconforming ectotherms, to determine the  $T_e$ , which is a measure of what temperatures are available in the habitat (Huey 1991; Diaz 1997; Blouin-Demers and Weatherhead 2002). The tubes were attached to numbered stakes, which were driven into the ground so that the tubes sat horizontally at ground level. Five loggers were placed in each of three different habitats: lawn, garden/flower bed, unmanaged mixed-grass prairie ( $n= 15$  per site,  $n=45$  total). At the end of the field season, I measured percent cover of grasses, forbs, low shrubs and bare ground, as well as maximum vegetation height and leaf litter depth within a 1-m<sup>2</sup> area around the logger. Temperature data were recorded by 44 loggers because one logger was not retrieved. Vegetation data were collected for 37 of the loggers due to loggers being removed accidentally by landowner prior to vegetation surveys. Mean daily maximum temperature, mean daily

minimum, daily mean, and mean daily standard deviation per logger were calculated from the raw temperature data. The effects of vegetation type on these variables were evaluated for each logger (lawn:  $n=10$ , mixed-grass prairie:  $n=15$ , garden:  $n=12$ ) using GLM and the Genmod procedure in SAS.

## **Results**

### *Vegetation Structure and Cover Availability*

During the walking surveys, 59 skinks were found in total. A total of 38.7 person hours were spent surveying prairie and 11.5 person hours surveying lawn and garden, with an average of 4.53 (prairie) and 1.44 (lawn) person hours per property over the summer. Four of the eight properties did not have gardens or flower beds. An average of 7 prairie skinks was found per property (Appendix 2). Prairie skinks were only found in mixed-grass prairie habitat, except for one property where six prairie skinks were found under cover boards in a mowed lawn. No prairie skinks were found in gardens, however through casual conversation, three of the landowners mentioned seeing prairie skinks in their gardens during the summers of 2009 and 2010.

At a microhabitat scale, prairie skinks were significantly more likely to be found in habitats with more artificial cover material ( $n=59$ ,  $p<0.001$ ) and higher percent cover of leaf litter ( $n=59$ ,  $p=0.010$ ; Table 1). There was no effect of specific types of vegetation cover such as bare ground, grasses, forbs, and low shrubs ( $p>0.136$ ; Table 1). At a local scale, prairie skinks found in the open were not closer to cover than were random points ( $n=16$ ,  $p=0.231$ ). However, prairie skinks found in the open only accounted for 27% of

total captures. At a landscape scale, prairie skinks captures per person hour of search effort increased significantly as cover material abundance per hectare increased

( $\beta=0.584$ ,  $SE=0.179$ ,  $p=0.023$ ,  $R^2=0.680$ )

### *Thermal Habitat Characterization*

The daily standard deviation of temperature in garden ( $n=12$ ,  $p<0.001$ ) and lawn ( $n=10$ ,  $p=0.001$ ) habitat differed significantly from prairie ( $n=15$ ) (Table 2).

Temperatures were less variable in these habitats than in open prairie. Temperature variation was not affected by other habitat variables (all  $p>0.111$ ). The mean daily maximum temperatures of both lawn ( $p=0.050$ ,  $28.9-46.0^\circ\text{C}$ ) and gardens ( $p=0.001$ ,  $25.0-42.9^\circ\text{C}$ ) were lower than in prairie habitat ( $33.6-46.3^\circ\text{C}$ ; Table 3). The mean daily minimum temperatures did not differ significantly among habitat types (Table 4). The mean daily temperature was significantly lower in gardens ( $p<0.001$ ,  $17.1-22.8^\circ\text{C}$ ) than in prairies ( $20.0-23.1^\circ\text{C}$ ). Mean daily minimum temperature decreased as leaf litter depth ( $p=0.032$ ) and percent cover of low shrubs increased ( $p=0.046$ ; Table 4). As vegetation height increased, daily maximum temperatures decreased ( $p=0.010$ ), while daily minimum temperatures increased ( $p=0.002$ , Tables 3 and 4). Daily mean temperatures ( $p=0.006$ ) significantly decreased as vegetation height increased (Table 5). Other vegetation variables, such as bare ground, grass cover, and forb cover, did not influence daily temperatures (all  $p>0.160$ ; Tables 3-5).

## Discussion

### *Vegetation Structure and Cover Availability*

Prairie skinks are generalists in terms of their use of vegetation. Even when vegetation was characterized as broad classes of grasses, low shrubs and forbs, I found that the type of vegetation had no impact on habitat use by prairie skinks at the spatial scales I analyzed. In Manitoba, prairie skinks have even been found in areas invaded by leafy spurge (*Euphorbia esula*), a noxious weed that has become common in mixed-grass prairie in the region (Larkin 2011). This suggests that mixed-grass prairie habitats composed of both native and non-native vegetation may be suitable as prairie skink habitat. My results were consistent with those of Pike and Roznik (2009), who suggested that small lizard species with broad habitat requirements can survive in disturbed habitat, especially if the modification happened many years before and there is no active anthropogenic disturbance. Prairie skinks are likely adaptable to vegetation composed of a variety of native and non-native species, as long as the structure provides appropriate microhabitat conditions.

Prairie skinks were more likely to use habitat with a higher percent cover of leaf litter. Leaf litter helps prairie skinks hide, because of their cryptic colouration, perhaps providing protection from predators. Martin and Lopez (1995) found that some lizard species would flee into nearby leaf litter when threatened. If there was a lack of leaf litter, they found that the distance at which the lizards would flee from a predator was greater. Ground dwelling lizards also find thermal properties of habitat with high litter cover to be thermally appropriate (Singh et al. 2002). This suggests that prairie skinks may use leaf

litter as cover to avoid predation while still maintaining appropriate body temperatures.

Artificial cover is another important component of prairie skink habitat, particularly in exurban landscapes. Larkin (2011) suggests it may be the most important habitat component in study sites at SWPP and CFB Shilo. At a local scale, prairie skinks were more likely to be found under a piece of plywood or scrap metal than in the open mixed-grass prairies surrounding it, regardless of the presence of leaf litter. Cover material provides shelter from predators, harbours prey items like crickets and provides protection for nesting sites (Bredin 1989, Krause Danielsen pers. obs.). Temperatures maintained under cover material may be lower than in exposed habitat surrounding it, and may provide thermal heterogeneity to the landscape, and thus opportunities for thermoregulation (Larkin 2011; Webb and Shine 2000). Prairie skinks found in the open were not associated with proximity of nearby cover, which suggests that although cover provides many essential qualities, it may be necessary for prairie skinks to use the surrounding habitat as well.

At the landscape scale, the amount of cover available might help counteract changes in vegetation structure (i.e. from prairie to lawn). If more cover is available on a small acreage, a larger prairie skink population can be supported. Five-lined skink (*Plestiodon fasciatus*) populations were also larger when cover was more abundant (Hecnar and M'Closkey 1998; Seburn 1993). Webb and Shine (2000) found that adding artificial cover, though unsightly, was effective in restoring lizard habitat in Australia. However, it is important that any habitat created by artificial cover would mimic optimal habitat (Croak 2010). Adding cover or leaving existing debris on private properties could

be helpful in restoring and maintaining prairie skink populations on private properties.

Cover material also provides shelter from predators. On exurban land, cover availability may be crucial to prairie skink survival because of the high abundances of introduced predators. Cats can pose a large threat to lizard populations on exurban land (Audsley et al. 2006). Cats forage close to home and will hunt despite receiving food from their owners (Gillies and Clout 2003, Larsen and Henshaw 2001). Of the properties I surveyed, one landowner had found a prairie skink that had been killed by their cat and another landowner said they did not see prairie skinks as often in the flower beds near their house since they got a pet cat. During landowner interviews, I discovered that 50% of landowners who owned cats had seen evidence of predation on prairie skinks (Chapter 4, this thesis). Predation costs may force prairie skinks to seek cover more often and may disrupt thermoregulatory behaviour as a result, as suggested by Downes (2001) and Cooper (1998) for other similar lizard species. Prairie skinks may use cover to escape lethal temperatures but temperatures under cover may not always meet their physiological needs. Therefore, higher predation pressure from cats may not only result in prairie skink mortality, it may reduce prairie skink fitness if they are forced to spend more time under cover.

The habitat modification on small exurban acreages mostly involves encroachment of non-native plants and yards characterized by a frequently mowed monoculture of non-native grass (Merenlender et al. 2009, Nassauer et al. 2009). While prairie skinks showed no preference for types of vegetation within native prairies, development and landscaping will likely have a negative impact on habitat structure.

Many landowners in the area had lived there for 10-20 years, resulting in minimal recent disturbance to the landscape (Chapter 4, this thesis). However, new exurban residential developments were in progress during the study and the land is become increasingly subdivided into smaller acreages (Chapter 4, this thesis). As development intensifies in the study area, less land will remain in a natural state and property aesthetics may play an increasingly important role in influencing landscaping decisions. Landowners often conform to the aesthetics of their neighbours and landowners moving from urban settings may view native vegetation and debris as unsightly (Krause Danielsen pers. obs.; Nassauer et al. 2009). Landowner education could help ensure that appropriate vegetation and cover material will remain on these properties.

#### *Thermal Microhabitat*

Temperatures varied more in mixed-grass prairie than in lawn or garden. This variability may be necessary for prairie skinks to maintain optimal thermoregulation throughout the day. Thermal habitat suitability is crucial for ectotherm survival and reproductive success because they need appropriate temperatures for optimal physiological function (Townsend and Fuhlendorf 2010). Prairie skinks require habitat heterogeneity so they can select microhabitats that allow them to maintain their body temperature within the optimal range of 22-35°C (Nelson 1963). Recent experiments have shown that prairie skinks show a preference for higher temperatures (33.5°C) under lab conditions (Rutherford et al. *in prep.*). However, in the field, prairie skinks are often captured at lower temperatures. Garden and lawn both provided mean temperatures within the lower preferred range of prairie skinks (18-23°C). However, maximum



temperatures in all habitats reached potentially lethal temperatures (mid 40°C). Garden temperatures were closest to the optimal temperature, but prairie skinks were not found in gardens during my surveys. Therefore, temperature is clearly not the only factor in microhabitat selection among the habitats available on private properties.

Habitat heterogeneity, which is inherent to native prairies, may provide a range of temperatures to suit the prairie skink's thermal needs. The structural variation in the vegetation usually results in some soil exposure. Sandy soil is a poor conductor of heat and therefore only the top few millimetres of the soil becomes hot (Tsoar 1990). Sand also releases heat quickly and therefore sand dunes often have large daily variations in temperature (Baldwin and Maun 1983). In addition to becoming intensely hot on the surface, the sand also reflects most of the heat upwards into the surrounding vegetation because of its pale colour (Hays et al. 2001). Therefore, a mosaic of vegetation and bare sandy soil, as is found in my study area, could have highly variable thermal characteristics. If the temperature is too hot above the sand, prairie skinks may burrow just below the surface to escape these temperatures. In contrast, grass in manicured lawns is composed of densely packed vegetation, often with little exposed soil. Thus, lawns may be unattractive to prairie skinks because they cannot access the sandy soil to escape lethal temperatures.

Temperatures were moderated by vegetation structure (i.e. height, leaf litter depth), not by vegetation type. Prairie skinks appear to respond more strongly to vegetation structure than species composition. Garden et al. (2007) found that lizards required structurally complex habitats over compositionally diverse habitats in developed

settings. Vegetation structure may therefore be similar in function to artificial cover. Reptiles that use rocks as cover select rocks of different sizes and thicknesses, depending on ambient temperature. For example, thicker rocks provide cooler refuges from extreme heat in the surrounding environment (Huey et al. 1989). Minimum temperatures were lower in areas with more percent cover of low shrubs and thicker leaf litter. Low shrubs and leaf litter may provide more choices for thermoregulation while still providing protection from predation. A diverse prairie with many different heights of vegetation and overall variation in vegetation structure may have enough thermal variation that prairie skinks can regulate their thermal profile while also finding refuge from lethal temperatures and predators.

## **Conclusion**

Exurban land in southwestern Manitoba consists of a matrix of lawn, aspen forest and prairie. This matrix appears to be suitable for prairie skinks, as long as there is sufficient cover available. To thrive on private properties, prairie skinks require refuges and appropriate thermal micro-habitat. The combination of native vegetation removal and the trend towards manicured lawns could prevent prairie skinks from escaping lethal temperatures and predation by house cats on private properties. These threats could be mitigated by the addition of cover to remnant patches of prairie habitat, but this may force prairie skinks to trade protection from predators for optimal thermoregulation. Landscaping with many different types of plant rather than a monoculture mowed lawn would also be effective, because it would provide heterogeneity in vegetation structure. On properties where mixed-grass prairie still exists, the addition of cover may allow

prairie skinks to escape predation while still accessing the surrounding matrix of appropriate habitat when required.

Despite the threats to prairie skinks, there remains evidence that they use habitat available on exurban land. Landowners who worked in their gardens see the occasional prairie skink but the frequency was not high enough to be captured at my sampling scale. Many of the gardens in the study area consist of raised beds constructed from rail ties or other wood, which may have provided artificial cover. Unfortunately, these types of cover could not be lifted, and therefore surveyed. As a result, prairie skinks may have been hiding in and around gardens but escaped detection. On a couple of occasions, I also observed juvenile and adult prairie skinks seeking shelter in a small crack in the concrete wall of a small garage. The use of outbuildings as cover may provide refuge from predators, although it is likely to be thermally sub-optimal. More research would help clarify how often these developed areas are used and whether they can provide additional refuge for prairie skinks on exurban land. However, developed land should be included in prairie skink conservation plans because pockets of land remain as mixed-grass prairie and at least some of the remaining land on many properties appears to be compatible with the needs of prairie skinks.

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## Tables

Table 1. Comparison of habitat characteristics near prairie skink capture locations (N=59) and random habitat quadrats (N=168), using generalized estimating equations (GEE).

Parameter	Estimate	Error	Z	P-value
Forbs	0.0077	0.0145	0.53	0.5929
Grasses	0.0129	0.0105	1.18	0.1620
Low Shrubs	0.0045	0.0319	0.32	0.6271
Litter	0.0224	0.0086	2.59	0.0095**
Artificial Cover	0.2140	0.0307	6.97	<0.0001***
Bare Ground	0.0225	0.0151	1.49	0.1363

Table 2. Generalized linear model (GLM) for mean daily standard deviation of temperature. Lawn and garden are significantly lower than prairie. Temperature variation does not differ significantly based on vegetation variables.

Parameter	Estimate	Error	P-value
Garden	-3.9556	1.0321	0.0001***
Lawn	-2.6728	0.8156	0.001***
Vegetation Height	-0.0172	0.0108	0.1106
Litter Depth	-0.0058	0.0128	0.6496
Bare Ground	-0.0213	0.0207	0.3045
Low Shrubs	0.0012	0.0144	0.9347
Grass	-0.0132	0.0155	0.3939
Forbs	-0.0099	0.0146	0.4996

Table 3. Generalized linear model (GLM) for mean daily maximum temperature. Lawn and garden are significantly lower than prairie. Maximum temperature decreases significantly as vegetation height increases.

Parameter	Estimate	Error	P-value
Garden	-8.6974	2.6755	0.0012***
Lawn	-4.1464	2.1142	0.0499*
Vegetation Height	-0.0717	0.0280	0.0103**
Litter Depth	-0.0111	0.0331	0.7364
Bare Ground	-0.0315	0.0538	0.5582
Low Shrubs	0.0103	0.0374	0.7831
Grass	-0.0288	0.0401	0.4715
Forbs	-0.0080	0.0379	0.8321



Table 4. Generalized linear model (GLM) for mean daily minimum temperature. Minimum temperature increases significantly as vegetation height increases, but decreases as litter depth and low shrub cover increases.

Parameter	Estimate	Error	P-value
Garden	-0.4059	1.8280	0.8243
Lawn	2.2048	1.4445	0.1269
Vegetation Height	0.0606	0.0191	0.0015**
Litter Depth	-0.0484	0.0226	0.0323*
Bare Ground	-0.0200	0.0367	0.5858
Low Shrubs	-0.0509	0.0255	0.0462*
Grass	-0.0127	0.0274	0.6428
Forbs	-0.0084	0.0259	0.7446

Table 5. Generalized linear model (GLM) for mean daily temperature. Garden is significantly lower than prairie. Mean daily temperature decreases significantly as vegetation height increases.

Parameter	Estimate	Error	P-value
Garden	-2.9448	0.8185	0.0003***
Lawn	-0.5773	0.6468	0.3721
Vegetation Height	-0.0235	0.0086	0.006**
Litter Depth	-0.0010	0.0101	0.9218
Bare Ground	0.0056	0.0164	0.7338
Low Shrubs	-0.0049	0.0114	0.6657
Grass	-0.0172	0.0123	0.1596
Forbs	0.0063	0.0116	0.5872

## Figures

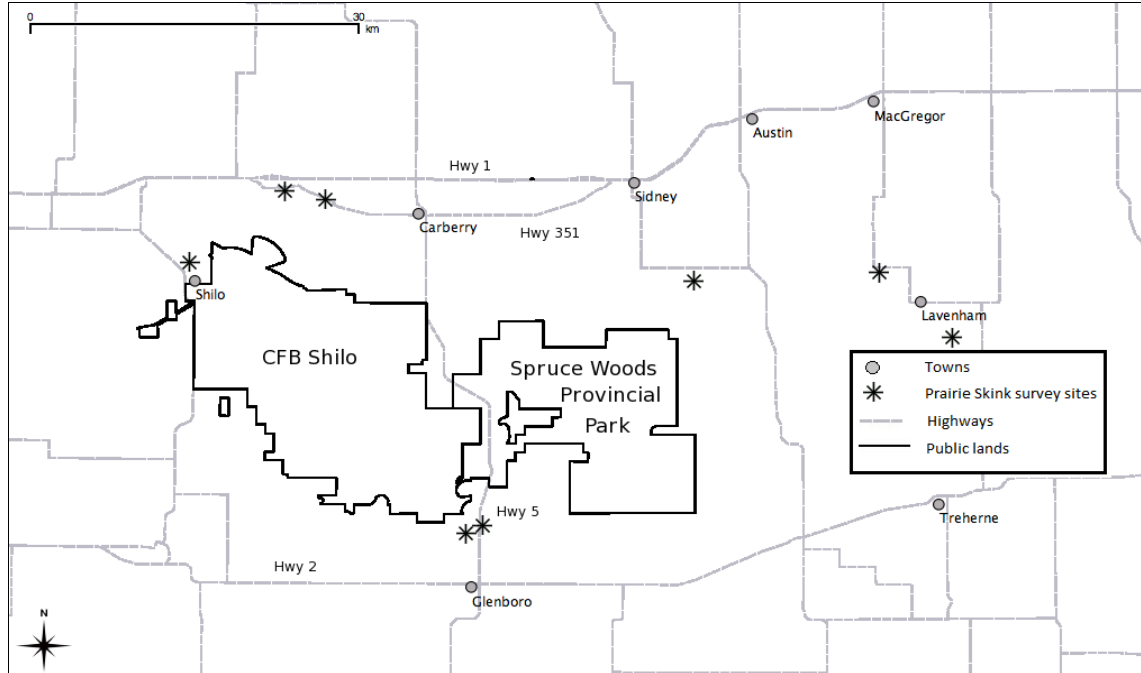


Figure 1. Map of prairie skink range in southwestern Manitoba with prairie skink survey properties shown with an asterisk (base layers from Manitoba Land Initiative).



Figure 2. Example of 1 x 1m vegetation sample quadrat around a prairie skink capture site.

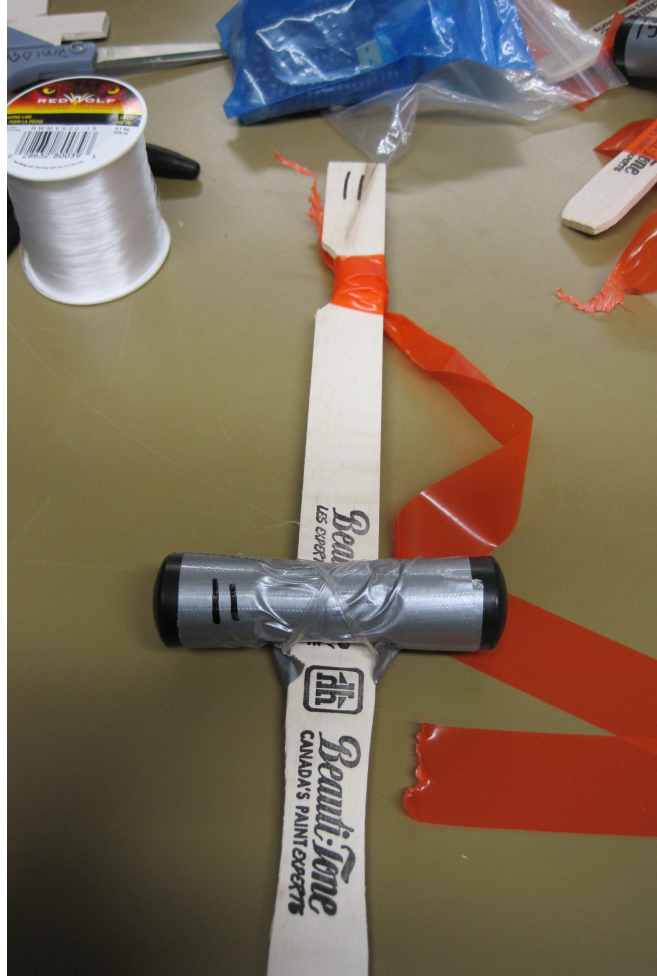


Figure 3. iButton® data logger enclosure, made from a stoppered copper tube and attached to a paint stir stick.

## **CHAPTER 4. EXURBAN LAND-USE AND LANDOWNER ATTITUDES TOWARDS PRAIRIE SKINKS IN SOUTHWESTERN MANITOBA: WORKING TOWARDS CONSERVATION ON PRIVATE LAND**

### **Abstract**

Exurban development (low density rural residential) is increasing in North America. This development often occurs in areas with high biodiversity. Land-use in exurban developments is different from that of public lands and preserves. Humans bring non-native plants and introduced predators to the landscape. However, rare species like the northern prairie skinks (*Plestiodon septentrionalis*) may find suitable habitat on these properties. To conserve species on private land, landowners must first be engaged. In this my study, I sought to uncover landowner perceptions and attitudes towards prairie skinks as well as determine if land-uses occurring on their properties were compatible with the habitat use of prairie skinks. I conducted 35 semi-structured interviews with landowners near Carberry and Shilo, Manitoba. I asked questions about land-use and prairie skink awareness. I found that most landowners were able to identify a prairie skink correctly, and 40% had seen prairie skinks occasionally on their properties. Half of the landowners who had outdoor cats had seen their cats hunting prairie skinks or observed dead prairie skinks. Habitat types where people had seen prairie skinks included near buildings, in flower beds, and amongst debris piles. While the prairie skink population numbers on private land were not estimated, prairie skinks inhabit exurban land, and landowners are, for the most part, aware of prairie skinks.

## **Introduction**

Human populations have altered the landscape irreparably, and in many places around the world, the highest human populations coincide with biodiversity hotspots (Hoekstra et al. 2005). Additionally, as human populations increase, many people have sought to escape city life and return to rural living. Exurban development, defined as “low density” residential development in a rural setting, is expanding in North America (Gocmen 2009). In the United States, there is a well-documented trend of people moving away from cities into the country, particularly to areas with high biodiversity and natural amenities (Gude et al. 2006, 2007). Similar exurban developments are happening in highly populated areas of Canada as well, such as the Greater Toronto Area (Gilbert et al. 2005). People have many different reasons for moving away from cities, but one common reason is to be closer to natural areas (Hansen et al. 2005).

Despite wanting to live near natural green spaces, such as parks, many landowners do not realize the potential environmental change that can be caused by exurban development (Merenlender et al. 2009). In particular, the increase in exotic plants and introduced predators can have a negative impact on the native flora and fauna of an area (Gude et al. 2007). Domestic cats can be detrimental to native birds, mammals and lizards, as they will hunt regardless of whether they are fed regularly (Larsen and Henshaw 2001, Gillies and Clout 2003). Many landowners may not know the full impacts of their activities and land use in the conservation of local species (Raymond and Olive 2008). It is, therefore, important to examine the perspective of landowners in relation to species at risk on private properties.

The northern prairie skink is listed as Endangered under Canada's Species at Risk Act (SARA) and its range in Canada is restricted to a small region in southwestern Manitoba (COSEWIC 2004). This small lizard is semi-fossorial and cryptic, and is found only in mixed-grass prairie and associated shrubland (Bredin 1989). The species uses artificial and natural cover to find refuge from predators, to provide suitable thermoregulation, and as protection for nesting (Bredin 1989). The main threat to prairie skinks is habitat loss resulting from the conversion of mixed grass prairie into cropland as well as the encroachment of aspen onto mixed-grass prairie (COSEWIC 2004). The encroachment of leafy spurge alters prairie skink habitat, but it is unclear if this has direct or indirect negative effects on prairie skink populations.

SARA only protects prairie skinks on public land and as a result, the majority of the studies on the prairie skink have been conducted in protected areas such as Spruce Woods Provincial Park (SWPP), Canadian Forces Base (CFB) Shilo, and various provincial Wildlife Management Areas. The habitat within and surrounding these areas consists of a mix of aspen woodland, mixed-grass prairie and stabilized sand dunes (Schykulski and Moore 2000). Within Spruce Woods Provincial Park, some areas are managed as mixed-grass prairie, mostly by using management techniques such as controlled burns, weed control and aspen removal (Schykulski and Moore 2000). At CFB Shilo, there is active military training which often results in the ignition of grassfires and they also conduct controlled burns. The base also manages invasive plants and conducts biodiversity surveys (Krause Danielsen, per. obs.). An estimated 60% of CFB Shilo consists of open prairie, while only 25% of SWPP is actively managed as prairie

(COSEWIC 2004). In some ways, it is difficult to manage an area like SWPP, because of the size of the park and the lack of resources to maintain processes such as fire and aspen control. CFB Shilo maintains more prairie areas through its military activities, but monitoring the biota of these “live” areas can be challenging. While these areas provide habitat for prairie skinks, attention should also be given to the smaller pieces of habitat on private land just outside these areas that may also be suitable as they provide important additional habitat to the population that complements regional protected areas.

Land-use on private land has a direct impact on habitat availability for prairie skinks populations. Outside of the protected areas, private land is used for cattle grazing and, increasingly, converted from mixed-grass prairie to potato farms (Mansell and Moore 1999). Because of the nature of the sandy soil in the Assiniboine Delta, the potato farms are intensively managed with high inputs of fertilizer, pesticides and water, as well as removal of native prairie vegetation. In Manitoba, there are conservation programs initiated by the provincial government and non-government organizations that aim to preserve mixed grass prairie habitat. Examples include a rotational grazing program, conservation easements targeting properties containing grassland and rare plants, and mixed-grass prairie inventories. The purpose of the inventories is to grade prairie habitat based on presence of native flora and rare species, while the other programs aim to manage and maintain existing grassland through providing incentives and encouraging landowner stewardship. Monitoring and protecting mixed-grass prairie on private land means this habitat remains available for prairie skinks and other rare species. However, these programs are generally used for large tracts of land and exurban land is often



excluded because of the smaller property size (MHHC pers. comm.).

One alternative to easements is the concept of conservation developments. This style of development aims to preserve ecological features and function, while still allowing for some higher density development in low impact areas (Pejchar et al. 2007). For example, instead of cutting down a woodlot to create cleared lots for houses and then planting new trees in each lot, the houses would be developed along the edge of the existing treed area, thereby preserving existing vegetation. Conservation development would ideally maximize important ecological functions such as maintaining biodiversity, aesthetic beauty, clean water, and food production. While this concept is still largely theoretical, it may be a valuable tool in conserving ecologically important land within exurban developments, like the new and ongoing developments near Carberry.

Local landowners on exurban properties near Carberry also have the potential to provide useful information to biologists regarding prairie skinks. Local ecological knowledge can be valuable in verifying and expanding science-based knowledge (Brook and McLachlan 2005; Gilchrist and Mallory 2007). First, it is necessary to determine what knowledge the landowners hold and whether they have an interest in conservation or the species in question. Once interest is established, creating community-based monitoring programs may be effective in encouraging conservation activities with long-lasting local effects (Danielsen et al. 2010). Citizen science can also be helpful for collecting data on private land where scientific monitoring protocols have been established (Cooper 2007). Since much of the prairie skink's habitat use on private property is unknown, it would be useful to encourage landowner stewardship and

participation, particularly on exurban land where habitat may still exist.

Since the land-use of exurban acreages does not necessarily require the removal of native vegetation, suitable prairie skink habitat is potentially available but land management may be very highly variable and often differs from land management on public land. In this study I defined the land uses on small exurban properties and determined whether they are compatible with skink conservation. I also determined where skinks occur on private land according to the landowners and what habitat they are using. I documented the level of awareness and knowledge landowners have about prairie skinks and determined ways to further prairie skink conservation on private property. This paper will identify some potential threats to prairie skink populations on private land and suggest management strategies for future conservation.

## **Methods**

### *Study Area and Interview Selection*

The study area is delineated by Highways 1 and 2 in the north and south, extending just east of Carberry (49° 52' N, 99° 21' W) and west to the town of Shilo (49° 48' N, 99° 38' W). These two areas were chosen because of their proximity to known prairie skink populations in Spruce Woods Provincial Park and CFB Shilo. Private land in these areas consisted mainly of small acreages (0.8 to 12 ha), which have not been converted to cropland. There were 4 distinct developments within the main study area. Two landowners east of Carberry fell outside these developments but had similar land-use and were still within the range of the prairie skink. I requested in-person interviews

from landowners within the rural residential area along Highway 351 (west of Carberry) and along Hoop's Loop road near Spruce Woods/CFB Shilo as well as east of Carberry, off Highway 1. Hoop's Loop/Deer Ridge consisted of two adjacent quarter sections (Figure 1). The northern quarter was subdivided into 37 properties, while the southern quarter is divided into 24 larger properties bordering the higher density residential area of the town of Spruce Woods to the south. The targeted area west of Carberry was composed of 4 sections that are bisected by Highway 351 and bordered by Highway #1 to the north (Figure 1).

There was large variation in the amount of time the participants had lived in the area (Figure 2). The longest resident in the entire area had lived there 40 years, but many others had lived there 20 years or more and one participant had moved there within the last year. The most well-established area was along Highway 351 and just to the north of this highway. This development had a mix of newly built houses, many within the last 10 years, and older mobile homes built 20 or 30 years ago. South of Highway 351, there was a newer development called Dane Rd, and participants from that area had all lived there less than 10 years. Hoop's Loop, near Shilo, also had some new development in addition to some older houses. The participants in this area had lived there from 3 months to 26 years. Some developments are more recent than others and this may impact how aware they are of prairie skinks, as well as the types of land-uses. The acreages ranged from 0.8 to 69 ha, but the majority of the acreages were 4 ha or less in size (62%) (Figure 3). The mean acreage size was 18.1 ha.

I used a case study framework and, due to the exploratory nature of the study,

samples were not randomized. Landowners were selected based the location of their acreages within the selected areas, except for two interviews that were conducted opportunistically. I contacted as many of these landowners as possible by phone and identified myself as a graduate student conducting research on the prairie skink in the Carberry/Shilo region, after which I asked if they would be interested in participating in a 20 to 30 minute face-to-face interview. Contact was attempted for 82 landowners. Seventeen people could not be reached after several attempts. Of the 65 people who were reached successfully, 54% agreed to an interview ( $n=35$ ). Reasons for declining an interview included: not interested (4), did not speak English (3), too busy (12), did not know anything about prairie skinks or had not seen them in awhile (6), and did not know what a prairie skink was (2). One respondent commented during an interview that many people in her neighbourhood were wary of telemarketing calls, which may explain some of the “no” responses. Following this initial contact period, I interviewed 35 people in total, 26 from the rural residential area just west of Carberry, two from the area east of Carberry, and 7 in the Hoop's Loop area, between June 24 and August 24, 2010.

Thirty-four of the interviews took place at the residences of the landowners, and one respondent chose to meet me at a local coffee shop. Interviews were informal in nature, and two included the respondent's children. The participant demographics were a mix of retirees, middle-aged couples and young families (Figure 4). Older couples with grown children made up the largest portion (40%) and couples with children still living at home were the second largest (31%). The interviews were conducted almost equally with men, women and couples interviewed together (Figure 5). Two participants chose to

involve the whole family in the interview process. Overall the demographics of the rural municipality of North Cypress consists mainly of adults under the age of 45 (64%) with 59% being married or common law (Statistics Canada 2007).

I focused my interview questions on two topics: landowner awareness of prairie skinks and land uses on exurban properties (see Appendix 3). All landowners consented to recording the interview using a digital voice recorder. I began the interview with a few basic questions like the size of the property, how long the landowner had lived there, and their occupation. I then asked questions about general land-use, such as mowing and other activities. After that I presented the landowner with photos of various local reptiles and one amphibian and asked them if they could identify them by name. I then moved on to the prairie skink awareness portion of the interview, in which I asked for more details of prairie skink sightings on their properties and how landowners felt about having prairie skinks on their properties. If the participants had seen prairie skinks on their property, the interview concluded with a walk around their property so they could show me where they observed prairie skinks. This walk took 2-50 minutes. At the end of the interview I asked if the landowner would be interested in providing prairie skinks sightings and I provided them with a FAQ sheet and monitoring information about prairie skinks. All interviews were done in compliance with University of Manitoba Ethics approval (Protocol # J2010:077) and Brandon University Ethics (June 2010) approval.

#### *Data coding and analysis*

I transcribed the interviews using ExpressScribe (playback) and Windows 7 Speech Recognition, which is integrated into the operating system. I listened to the

interview in my headphones and then spoke the questions and responses into the microphone attached to the headset. I uploaded my completed interview rich text files to TAMSanalyzer, a qualitative coding and analysis program. My coding structure included two groups of codes, based on the two sections of the interview (Tables 1 and 2).

Information from the interview and the walk were coded together because the information often overlapped. The first code group included questions about the land itself and activities taking place on the land (Table 1). These codes were based primarily on the questions and secondarily, emergent themes from the responses to the questions. The debris pile and habitat type codes provided information on the composition of the property. Recreation activities and maintenance of the property were also relevant to prairie skink habitat availability and modification. Although activities and maintenance were addressed in separate questions, there was some overlap and therefore the results of both questions were combined. For example, some landowners listed mowing as an activity, while others referred to it as maintenance. Some referred to gardening as an activity but included tree planting as maintenance, but for the purpose of my analysis, all landscaping themes were included under the “maintenance” category. I also developed a separate code for the presence of pet cats and any comments about whether landowners had observed their cats with prairie skinks.

The second group of codes in the coding structure were directly related to prairie skink encounters and landowner knowledge (Table 2). Many of these codes emerged from the interview responses, such as “willingness” to participate in prairie skink related to conservation or monitoring activities, positive or negative attitudes towards prairie

skinks and knowledge of prairie skink habitat, appearance etc. The other codes in this group emerged from specific questions about prairie skink encounters, such as frequency of encounters and where prairie skinks were observed on the property. The frequency data were broken down into categories based on the responses: often (daily or weekly), occasionally (yearly), rarely (biannual), or never. Locations of prairie skink encounters were also broken down into habitat types. These categories include flowerbeds/gardens, rocks, debris piles/compost, boards, soil (includes dirt piles), grassland, human development, roads and rail ties. Rail ties have a category separate from boards because ties have been used extensively in the area for landscaping. The “human development” category was used for prairie skink sightings in or around buildings such as houses, garages, or sheds. Some landowners may have seen prairie skinks in several different habitat types.

The photographic quiz at the beginning of prairie skink section served as a check to ensure landowners knew what prairie skinks were and to initiate the discussion of prairie skink sightings. Even if landowners did not know the names of the species depicted, they could still participate in the rest of the interview by referring to the photos, and I could feel confident that we were discussing the same species. The percentage results of the quiz were based on whether landowners knew the correct name of the species depicted. The quiz included photos of 4 snake species found in the area (western hognose, red-sided garter snake, smooth green snake, and red-bellied snake), as well as photos of a prairie skink and a tiger salamander.

Once my interviews were coded, I used the search function in TAMS to obtain

quotes and information from each of the coded sections. The qualitative data were compiled as percentages where possible, such as the quiz results, prairie skink habitat encounters, frequency of encounters, mowing, cat presence, and livelihood. Quantitative data included acreage size, amount of time and ratings of five close-ended statements. Qualitative information was also obtained from the data in some of the categories, including maintenance (the “do nothing” mentality), knowledge or lack of knowledge, and feelings towards prairie skinks.

## **Results**

### *Exurban Development in Manitoba*

Landowners had various reasons for moving to their current residences and some had more than one reason for moving there (Table 3). The majority of landowners stated that they wanted to be away from the city or that they wanted to be in the country (60%). The next most common responses were: because they liked the landscape of the area (31%) or that they moved there because of their job (29%). Only 9% said they moved to the area because of the recreational activities available to them, specifically the park nearby. One landowner had lived along Highway 351 but had moved to a larger acreage east of Carberry because the other area was becoming too developed for her liking (Interview 30).

### *Land Management*

All landowners interviewed had a lawn area that was mowed regularly. The majority of landowners interviewed mowed only a small area of lawn compared to the



entire property. When asked to quantify the amount of lawn, a common response from the landowner was “just a bit around the house”. Some people responded with a percentage estimate, or a number of acres, which was then converted to a percentage. The responses of, “just a bit” were categorized as less than a quarter of the total acreage and were combined with numeric values in the same category. This category accounted for 54% of the participants (Table 4). A further 17% of participants mowed between one quarter and half of their properties, and 25% of the participants mowed half to all of their property. One landowner did not yet have a lawn but indicated that she would likely sow grass in a small area that had been disturbed around her recently built home.

The percentages given can be somewhat misleading because the amount of lawn area may or may not correspond directly to the amount of open grassland on the property. For instance, one landowner mowed half of his 4.2 acre property but the other half was entirely treed (Interview 11). Mowing a lawn was not always differentiated from mowing grassland, and sometimes the lawn was made up of grassland. One landowner mowed the largest prairie areas on his 11.5 acre lot until they became like a lawn (Interview 13). The rest of his property he described as “bush” with some trails. Another landowner mowed all of the grassy areas on his property, saying that it was just “prairie grass” (Interview 27).

Some landowners were conscious of the difference between mixed-grass prairie and lawn. Fourteen percent of the landowners mowed mixed-grass prairie as a maintenance practice on a less frequent basis, to control undesirable species (Table 4).

On the upland areas I probably mow it maybe three times a year, depends on how the poison ivy is growing. And down here of course on the regular lawns, on the

low areas here, that's a couple times a week maybe. (Interview 5)

And we mow. We mowed the aspen, poplar, trying to keep them down. Snowberry. We try to control snowberry. (...) Minimal [lawn]. Front yard and my husband mowed this a couple weeks ago. And we likely won't mow it again. But again the prairie is losing the battle here. There was some really nice prairie plants in this area when we first moved here. So front yard, back yard basically, just like a city lot, that's all we mow. (Interview 12)

Mowing frequency varied but the dry climate and sandy soil seemed to be a factor in how often lawn needed to be mowed. Often lawns in the area are brown by midsummer and because of this landowners sometimes give up on maintaining a lawn altogether, or at least minimize the maintenance activities like watering and mowing (Interview 1, Interview 21).

Landowners were asked to rate four statements regarding the maintenance of their properties (Table 5). The results indicated that many landowners highly value both native vegetation (bush and grassland) and a mowed lawn area. In fact, 100% of the landowners interviewed indicated they agree or strongly agree with the statement “I value leaving some native bush and grassland on my property”. Meanwhile, 85% of participants agreed or strongly agreed that “Having a mowed lawn increases the aesthetics of my property”. The opinions of participants varied more when asked about the importance of tidiness. However, 40% strongly agreed that a tidy yard was important to them, and 54% strongly agreed that tidy neighbourhoods were important. There was some difference in opinion about what constituted tidy. For some it meant the lack of scrap piles and junk (Interview 2), while for others it meant having no overgrown vegetation (Interview 11). Some landowners felt that untidiness was less conspicuous in the country because there was more land available to hide the debris, and therefore less of

a problem (Interview 16).

Despite the importance of tidiness to the participants, many of them had debris or wood piles of some kind on their properties. The majority of landowners described their debris piles as composed of natural branches and deadfall from the wood lots on their property (57%). Some had piles of lumber (31%) and two landowners had a wood pile but did not specify whether it was deadfall or lumber. About 17% of landowners had other types of scrap such as metal or other materials, and 20% of the participants had more than one type of debris on their properties. The extent of the debris and length of time the debris was present on the property was not measured, but it seemed to vary between landowners. During my walk I observed a couple of properties with extensive debris throughout, but more commonly landowners had one small pile, or a bit of lumber piled near a shed. Some of the people who had brush piles said that they burned the pile in winter (14%). Such short term debris is likely not as useful to skinks because they tend to colonize long term undisturbed debris.

Landscaping was another common land use (Table 4). Eighty percent of participants had a garden, flower beds, or both. Landowners commonly saw prairie skinks in these areas and I saw a prairie skink in an overgrown flower bed during one of the walkabouts. Planting trees was also common; 29% of participants had planted trees of some sort, especially on acreages in areas dominated by open grassland. Some landowners planted native trees:

Oh about 20 years ago, not long after we moved here, we put in maybe 400. Now I can't remember if it's white spruce or black spruce. (...) Whichever was the most common, we planted the other one because that's what we could get very inexpensively. Anyway we tried to plant through some of this area with some of

the spruce. And out of all those trees there's not very many still around. (Interview 12)

Apparently we talked to someone who knew the past owner, and that past owner had, of the whole section here, had just harvested the spruce trees. There were no spruce trees on this property when we bought it. So we've taken it from other peoples pastures, like people we know. Just re-put it here. So they're like the native species. (Interview 15)

while others planted non-native species, often through shelter belt programs.

We're planting close to 400, around the border, shelter belt thing. The winds are crazy here. (...) Pekingese poplar, like giant poplar. They're supposed to do better in sand. And caragana and stuff, other poplar. There's not enough sponge to hold the water. We should have just done spruce or scotch pine. (Interview 34)

I'd like to get in one of those shelter belt program. I want to keep on planting spruce. I put a whole bunch of scotch pines down here, scotch pines on the front of the property. I'm a big tree guy so. 'Cause the wind really howls here, 'cause we're kind of elevated where we are, and the wind really whips through here in wintertime and in summer. (Interview 14)

During one of the walks with a landowner, I saw a prairie skink crawling near a newly planted shelter belt. Whether tree planting is useful or detrimental to prairie skinks is unclear. However, one landowner felt very strongly that planting Scotts pine (*Pinus sylvestris*) was detrimental to prairie and prairie skinks.

A few years ago the boy scouts were doing one of their tree planting things south and east of us there, close to the river. You know they did their furrows and they put in their scotch pine which they promised they wouldn't plant anymore on native prairie. I'm with the Westman Wilderness Club and I used to be with the Sierra Club and we tried to make an issue out of this. Don't put scotch pine on the native prairie. Don't put anything on the prairie! But don't put scotch pine! (...) I found out after the fact that they were doing the furrows and putting in the trees and these kids were seeing skinks. And they did not know what they were, so they killed them! And I was horrified! I was absolutely horrified because we were angry at the scouts for planting a non-native species and for planting where they shouldn't be planting and then the instructors weren't even well versed in flora and fauna right. (Interview 12)

Another landowner commented on the same tree planting activities but felt that perhaps

prairie skinks were adaptable enough to be unaffected by the tree planting activities.

But our whole government quarter over here, next door, is planted down to scotch pine. And that would have happened 15-20 years ago and you probably heard the story if you've been down at the Park. It was planted by boy scouts and a couple of local activists, we'll say, complained and had a bunch of the seedlings pulled up. Cause it's not natural skink habitat eh. But I can't say that I've gone looking for skinks in the midst of all those [scots pines], but the way [the skinks] move into everything around here, I gotta wonder that they'd be put off by, you know, if you walk into your shop and you see a skink on your floor, I don't think he really cares if it's a scotch pine he's hiding under or anything else. I think they're pretty adaptable. (Interview 17)

Not all landowners were actively maintaining their entire property. About half the landowners commented that they refrain from disturbing or even maintaining a portion of their property. One landowner even said that she and her neighbours bought up 30 acres (12 ha) between them so that the land would not be developed for more acreages (Interview 12). A couple of landowners had a very small lawn area, and left an area of grassland wild because they liked seeing the wildflowers that grew there.

We've put the little bit of lawn here but for the most part everything beyond the house is in its natural state. (...) Some of our neighbours mow their whole ten acres. And I mean we love this because of the wildflowers, because of all that stuff. (Interview 8)

But I just let it grow 'cause I like the wildflowers and the prairie grass. I go part way but I leave the rest. I love the wildflowers so I'd just rather not touch it. (Interview 4)

Many landowners also enjoyed seeing wildlife on their properties and sought to preserve habitat for it.

When we realized that we decided we wouldn't touch it at all because it seemed so fragile. So we decided not to do anything to it, just leave it. And so we have deer and coyote and stuff and we just leave them. (Interview 3)

And the rest is left wild. We keep the bush close to our house (...) for the animals. We didn't get this idea to clear out everything. Because I mean, there's deer trails

through there. (Interview 6)

Other activities included small scale agriculture such as chickens and horses, walking or hiking, swimming in a backyard pool, sports (golf, playing catch, skiing), motorized recreation (ATVs, snowmobiles, dirt bikes) and other activities (Table 6). When asked about which activities took place on their properties, 57% of participants responded with statements like “not much” or “we like to leave nature alone”.

#### *Landowner Awareness and Perceptions of Prairie Skinks*

In the photographic quiz, the most recognized was the prairie skink (85%), followed closely by the garter snake (82%), the least recognized photo was that of the red-bellied snake (3%) (Table 7). Some participants used slightly different common names, such as “garden” or “gardner” snake instead of “garter”, or green grass snake instead of smooth green snake. These responses were counted as correctly naming the species, because these variations in common name were known to me before the interviews. However, 11% of participants misidentified the hognose snake as a rattlesnake or bullsnake, which was not counted as a positive identification. All of the misidentification of prairie skinks was attributed to confusion with salamanders (14%), but only 49% of the participants could correctly identify a tiger salamander from the photo. Many landowners had never seen salamanders on their properties but 97% had observed prairie skinks at least once. It is important to note that the landowners who chose to participate in my study had likely heard of prairie skinks before agreeing to participate but this does not have a bearing on whether they knew how to differentiate them from salamanders.

Many of the participants who correctly identified prairie skinks were confident in their knowledge, often giving responses such as: “That's definitely a skink”. One landowner admitted that after I phoned her about an interview, she looked up prairie skinks on the internet and realized that she had seen them on her property (Interview 27). A couple of the landowners were confused about the colouration and appearance of prairie skinks. They described colour combinations that were more exaggerated than reality but this is likely because of the brevity of prairie skink encounters resulting in embellishments.

It was just a baby. The babies look blue. Totally blue. (...) Well the whole thing looks blue when they're only about this long. (Interview 1)

I had a roll of weed barrier laying in the grass here one day and I saw this glimpse of shiny purple. (Interview 14)

Sometimes they had very different colours on them. Is that a male/female thing? The ones that are very bright, are they males? Because some had gorgeous greens and blues on them. (Interview 9)

Prairie skink encounters were common throughout the study area (Figure 6). Forty percent of landowners saw prairie skinks occasionally, while 31% saw them rarely and 26% saw them often. These results did not reflect the actual numbers of prairie skinks in the study area, because landowners had no way to determine if they were seeing the same prairie skink numerous times or different prairie skinks. Also some landowners acknowledged that they were more likely to see prairie skinks when they were working outdoors, or in areas of the property they frequented often.

I'm not sure that's because that's when they're out or it's more when we're doing stuff. Now that we get into summer we're not doing as much. We kind of try to get whatever projects we're going to do and stuff like that done outside, so that we can sit out in a boat in summer. We're not often doing a lot of stuff outside in the

hotter months, as far as projects stuff, moving things around. Whether it's coincidence or whether that's when you see them I don't know. (Interview 23)

I don't think I've seen one at all this year. Mind you I haven't been out in the yard as much this year as other years. (Interview 8)

I also asked participants to tell me what they knew about prairie skinks. All but one of the participants had heard of prairie skinks before I called them and so I asked them where they had first heard about them (Figure 7). The majority of landowners had first heard about prairie skinks either from Spruce Woods Provincial Park (35%) or from someone they knew (29%). Another 23% could not recall where they had heard about them. Only 6% of landowners had heard about prairie skinks through newspaper articles or the internet. Many participants also indicated that when they first saw prairie skinks, they did not know what they were and some had only found out that they were called “prairie skinks” after they had seen them.

I found one [and] I didn't know what the heck it was, I thought maybe it was somebody's, some kid's pet that got loose. And then I went on the internet and I researched it. And then also all the articles that started showing up in the paper about the skinks around Carberry (Interview 14)

I'd seen them and didn't know what they were. Our neighbour, she mentioned them one day, her father was an old naturalist who died fairly recently in his 90's. He was kind of an old wildlife, nature man, survivalist. (Interview 18)

We didn't know that they were called skink. We know they're always around here but we didn't know. (Interview 19)

Others felt that prairie skinks were commonly known:

Oh well when you live in Carberry you hear about skinks. And I had a friend who was really, I have friends who are involved in the Seton Centre and everything. And they kind of let us know how rare they are, and if you have them it's kind of special. So that's where I heard of them first. (Interview 30)



and some had known about prairie skinks for a long time.

Actually, I was involved in outdoor education in school. And we would take kids down to Spruce Woods and of course the interpreters down there talked about skinks. And then you would hike in to the spirit sands. So I've heard about them for a long time, 40 years ago I heard about skinks and so you're aware of all of them. And I'm also a boy scout leader one time and so you're always telling kids about native snakes and reptiles in this area. (Interview 22)

I probably originally heard about them about 50 years ago, but I never really encountered them until I moved here 20 years ago. But I encountered them right away. (Interview 5)

Prairie skink knowledge varied among the participants. Some observed prairie skinks regularly and were keen to know all they could about prairie skinks. Others only knew that they had seen them, and perhaps that they were a lizard native to the area. I categorized the types of knowledge held by landowners into the following categories as they emerged from the data: food, habitat, appearance, type (adult, baby etc), and whether they knew about the prairie skink's ability to shed its tail. The prairie skink's ability to shed its tail seemed to be widely known and 37% of landowners mentioned it. Fourteen percent of participants had even seen a prairie skink drop its tail first hand or had just found the tail.

Some of the participants also commented on prairie skink behaviour. Some thought the prairie skinks were curious, and would emerge from their hiding place when people were active in the yard. Others thought that prairie skinks were secretive and tended to run and hide. Many also noted that prairie skinks like to sun themselves. A few commented on how fast prairie skinks were and that they would only see a flash of something in the grass.

They seem to be kind of curious. I've seen them sort of almost like playing. I

mean that was sort of like the impression that I had, and probably they were just hiding or something. They gave me the impression they were sort of playing. (Interview 5)

They move very quickly, eh? You think you see a flash of something. (Interview 6)

When I walk by I see them, especially when it's nice and warm. They stay in the heat I guess in the sun. (Interview 11)

And then the way I spotted them is, one day I was weed whacking and they're very curious little guys. They hear anything, they come out. (Interview 14)

When we see them here, they seem to be going after sun, basically eh. They're going to go sun themselves in the middle of the afternoon or else you may have scared one up with the lawn mower it was hiding in a pile of grass or debris or something, leaves or whatever and the lawn mower scared them up and they'll go scooting across, go hide in another spot. I've actually sat here on a Saturday afternoon, enjoying a cold beer, and looked down and seen one just sitting on the boards down there sunning itself. (Interview 17)

Overall landowner knowledge varied considerably. Related to this was the apparent interest and desire to know more about them. Many of the interviews ended with landowners asking me questions about prairie skinks. Landowners usually wanted to know more about their biology, such as food preferences or how many eggs they would have. Forty-eight percent of landowners even made statements about their lack of knowledge regarding prairie skinks.

I know nothing about them at all besides "save our skinks" (Interview 10).

I guess for me I wouldn't know what to look for, and I don't know where they live or where they hang out (Interview 24).

We had no idea what they were, when we seen them. It was just like oh my god what is that (Interview 32).

I don't know if they like sunning themselves or not. I don't know (Interview 20).

Through the interviews I also wanted to uncover how landowners felt about

prairie skinks. Overall landowners were positive to neutral. Half the landowners thought prairie skinks were cute, or said they enjoyed seeing them on their property. Some of these landowners also mentioned that they felt having an endangered species was a privilege and was one benefit of living in the country

I have no problem with them. But, I mean, also kind of neat because, you know, part of living in the country (Interview 21).

It's like a gift I guess. It's just kind of a special thing to have. If we see them we try to keep the cats away. We're not going to go out of our way to kill them or anything like that (Interview 30).

Twenty percent of the landowners mentioned some distaste towards prairie skinks or reptiles in general. Despite this, they did not mind having prairie skinks on their property. One woman viewed skinks as valuable in connecting her young son to the natural world (interview 32). Another man who did not want to touch them but said he would not harm them if he saw them on his property (Interview 18). Another woman even stated at the beginning of the interview that prairie skinks were ugly but had changed her mind by the end, saying “It's actually kind of cute now. Now that I know he's endangered” (Interview 19). Regardless of whether the landowners thought the prairie skinks were cute, many of them said that the prairie skinks were simply there and they did not really pay much attention to them. Generally, when asked about how they felt about having an endangered species on their property, landowners responded with appreciation or neutral acceptance.

### *Prairie Skink Habitat*

Habitat availability on private land is important for prairie skink existence. Many landowners knew something about prairie skink habitat needs, even if it was only that

prairie skinks seemed to like hiding in their flower bed. Forty percent of the landowners commented specifically on the fact that prairie skinks liked to be underneath debris like plywood or other scraps. Many landowners also knew that prairie skinks liked sandy soil but very few of them mentioned mixed grass prairie when discussing prairie skinks, indicating that there may be a lack of knowledge about natural habitat preferred by prairie skinks. This is not particularly surprising since landowners rarely encountered prairie skinks in mixed grass prairie (Table 8).

Participants encountered prairie skinks in various locations around their property, and through the interviews it became evident that prairie skinks were found in particular habitats fairly predictably (Table 8). Landowners found prairie skinks most commonly around human development (i.e. near houses, driveways, and out-buildings). Other frequently mentioned habitat included debris piles and lumber (40%) as well as flower beds and gardens (37%). Specific cover types associated with landscaping activities, such as rocks (23%) and rail ties (29%) were also common places to find prairie skinks. Prairie skinks were even found in sand piles or sometimes during transfer of soil from one place to another (26%).

Down in the dirt pile, in the sand pile down there, I was taking sand out with a shovel one time and I unearthed a skink, back into a hole. And then these two I dug out of here, just last week with a tractor and a bucket.(...) There's a sand pile out of the bottom, pure sand. I recall one year getting a load of sand over there, and there were two skinks, when we skimmed the top off. The two of them just back in the sand, a couple inches below. I'd never seen any holes. (Interview 7)

By the little sand pile down here, we can go for a walk. But it was in the sand pile. When our kids were little we would keep it dug up all the time. And they would be playing in the sand and they would take a skink up now and then. And my wife would bring her kindergarten class out here, usually once a year. And whenever they would be digging in the sand pile a fair amount, and they would quite often

dig up a skink. (Interview 22)

During my visits I confirmed the presence of prairie skinks in many of these habitats, including rail ties, among rocks, in a flower bed, under a piece of plywood, near a garage and in a sand pile. Participants often saw prairie skinks right around their homes and other buildings on their properties (57%) and rarely saw prairie skinks in native grassland (17%).

### *Threats to Prairie Skinks*

Some participants encountered prairie skinks that had been captured and brought home by pet cats. Fifty percent of the landowners interviewed did not own cats, but 82% of the participants who did own cats stated that their cats spent at least some of the time outdoors. Of the landowners with outdoor cats, 50% had observed their cat with a prairie skink or had seen the remains of a prairie skink that had been captured.

Last summer the only reason why we saw one was because the cat had caught one and killed it. (Interview 9)

Like I said before when we often do you see them dead, because our cats are outdoor cats and they are mighty hunters. (Interview 32)

Thirty-five percent of landowners with outdoor cats denied that their cat would catch a prairie skink. An additional 5% of all the landowners knew someone whose cat had killed a prairie skink.

I know my next door neighbour, he hasn't seen a live one, but I guess his cat caught one and brought it home. (Interview 14)

One landowner even reported that her cat had only caught a prairie skink tail, indicating that some prairie skinks may escape being killed by cats.

When she goes out she's a hunter. And I remember the first time she brought back the blue tail. And I had no idea what this thing was even called. For what it was, or would it looked like. She brought back just the chunk of blue tail. And I thought to myself, well she ate the rest of it. (...) And then [my neighbour] explained, and I guess I don't understand yet, they explained that that's a defense mechanism, that their tail can break off, so they can get away. And here I thought my cat was so brave, and such a fighter and all she brought back was the tail. (Interview 21)

Some landowners actively try to keep their cats away from prairie skinks or have rescued prairie skinks if they saw that their cats had caught them, while others indicated that the actions of their cats were beyond their control.

Unfortunately they're really good hunters. That's why we have them. Whenever we catch them with a skink we try and get it away from them. (Interview 30)

Just want [the skinks] to still be around so leave 'em be. Let them do what they need to do to make us have more. Except for my cats that catch them every once in awhile. I can't do much about that. (Interview 9)

### *Prairie Skink Conservation and Management*

During the interviews, many landowners expressed a willingness to help prairie skinks (Table 9). All of the landowners said they were willing to submit future prairie skink sightings as part of the Save Our Skinks initiative. However, willingness may not translate directly into action as only two of them submitted sightings at the end of fall 2010. A third of the participants said they had taken or were willing to take actions to prevent death of a prairie skink, or prevent damage to prairie skink habitat. Fourteen percent were willing to make more habitat, such as setting out cover boards. One retired landowner was very enthusiastic about building a larger structure in a sand pile in his yard for prairie skinks to hide in. Twenty-two percent of the participants stated that they would like to do something to help prairie skinks, but did not know what to do.

Additionally, 49% landowners felt that they would not change how they managed their property because they felt that a) what their current activities and maintenance practices were not destructive and therefore did not need to be changed, b) they did not know what they could change or c) they felt that prairie skinks had enough habitat because much of their property was left natural.

## **Discussion**

### *Exurban Development in Manitoba*

The small acreage developments near Carberry and Shilo are examples of exurban development in Manitoba, as described by Merenlender et al. (2009). The properties are small and the land is generally not productive for agriculture because of the sandy soil. The people who own the land are not managing it for a particular purpose. While some of the landowners work locally, many also commute to the larger municipality of Brandon. The reasons given by landowners for living in the area are consistent with other studies conducted in the United States, which emphasize the desire for a rural lifestyle over life in the city (Gude et al. 2006; Gocmen 2009). Literature on this phenomenon in Canada is limited, with the exception of the developments around Toronto, Ontario. Many of the people living in the Greater Toronto Area (GTA) are affluent enough to do so, and choose to move outside the city to enjoy a “great quality of life” (Gilbert et al. 2005). Indeed, the majority of the participants in my study also stated that they moved to their acreage to escape the city and enjoy a country lifestyle. However, there is at least one important difference between the GTA and southern Manitoba. The population pressure in the GTA

is much larger than that of Manitoba, since the GTA is one of the fastest growing urban area in Canada (Gilbert et al. 2005). These pressures create more conflict among policy-makers, developers, conservationists, and landowners than would occur in Manitoba. Despite the small scale, the type of development is the same in Manitoba and the impacts of the exurban trend still affect the landscape. At this early stage, it may still be possible to minimize environmental damage caused by exurban development in Manitoba.

### *Land Management*

Within Spruce Woods Provincial Park, aspen forest and leafy spurge are encroaching onto prairie habitat (Schykulski and Moore 2000). In CFB Shilo, prairie habitat is maintained in part because of military activity (COSEWIC 2004). Many of the larger tracts of prairie in the area around SWPP have been turned over so that large scale potato farms can be planted (Mansell and Moore 1999). On the private properties I studied, some people had been living there for up to 40 years, often with little disturbance to the landscape around their yards. However, there is a considerable amount of new development, particularly within the last decade. In the Hoop's Loop neighbourhood, I observed that much of the new development is encroaching onto open prairie, while the older houses were usually along the treed edges. Many of the newer developments are also smaller acreages, 2 to 5 acres (0.8 to 2 ha) in size, while the older subdivisions are larger. The trend towards smaller subdivisions means that more of the land will be impacted directly by the landowners, whereas larger acreages allow some habitats to be left in a “natural” state. Prairie skink presence should be monitored and compared on the newer and older properties in order to determine whether further subdivisions will have



negative consequences on prairie skink populations.

The role of aesthetics in prairie skink conservation is complex. While most landowners indicated that neatness was important, they also said other habitat like native prairie was important too, so a mix of vegetation types exists on these exurban properties. All of the landowners interviewed agreed or strongly agreed that native vegetation was important but the majority also thought that a mowed lawn was aesthetically pleasing. This finding agrees with the research of Nassauer (1995), where she discussed the need to put the “messiness” of nature into a frame of neatness to create the aesthetic of a tended landscape. The amount of allowable messiness varied among landowners, as did the size of the mowed area. Nassauer (1995) also indicates that forest is more highly valued by exurbanites as having more “natural” aesthetic appeal than grassland. Many of the landowners in my study also agreed with this, as they viewed grassland as something to be planted over with trees, or to be mowed as a lawn. Since prairie skinks use mixed-grass prairie habitat primarily, properties with large expanses of lawn may not be as suitable as those with prairie, unless habitat is created elsewhere to compensate.

#### *Landowner Awareness and Perceptions of Prairie Skinks*

Prairie skinks are unique to this particular region of Manitoba (Bredin 1989). Because of this restriction to a particular geographic area they cannot be transplanted to other areas as development occurs. It is important to work with private landowners to conserve prairie skinks because of the lack of legislation in Canada for the protection of species at risk on private land. To understand the landowners' perceptions of prairie skinks, I first needed to determine whether prairie skinks were recognizable to the

landowners, because landowners cannot conserve what they cannot recognize. Once they had looked at the photos I presented to them during the Quiz, most landowners pointed out the prairie skink as the animal they had observed, even if they could not differentiate between a prairie skink and a salamander as named species. This result confirms that prairie skinks and tiger salamanders are easily distinguishable to an untrained eye. It is important to note that some of the landowners who refused an interview stated that they did not know what a prairie skink was, so the participants of this study may be biased towards those landowners who had heard of prairie skinks before.

Prairie skinks do not pose any sort of threat to landowners or their livelihoods, nor do landowners perceive prairie skinks to be intrusive to their daily lives. According to Brook et al. (2003), willingness to conserve may be based on economic, recreational and personal value considerations and if the endangered species is viewed as a contrary to these, landowners are not as likely to conserve it. Prairie skinks seem to be either intriguing or benign to the people who live on these properties. Furthermore, some landowners view prairie skinks as one of the benefits to living in the area. The positive attitude of landowners increases the likelihood that prairie skinks will be allowed to persist on these properties.

#### *Prairie Skink Habitat*

Prairie skink habitat availability varies among properties. Some landowners had larger tracts of prairie, but many had mostly forest, or a mix of forest, prairie and lawn. Similar to other reptile species, prairie skinks likely require structurally complex vegetation and heterogeneous thermal habitat (Blouin-Demers and Weatherhead 2002).

Cover availability is also an important feature of their micro-habitat (Chapter 3, this thesis). Prairie skinks seemed to be able to persist even on properties that did not have high native habitat complexity. Landscaping, particularly flower beds and rock beds, may play an important part in providing prairie skink habitat, particularly on properties with larger mowed lawns (Scott 2005). Other studies have shown that lizard population have increased once additional cover was added to the landscape (Hecnar and M.'Closkey 1998; Webb and Shine 2000). Prairie skinks seem to be adaptable to human development as they were seen regularly near houses, sheds, greenhouses and in debris piles (Figures 8 and 9). However, landowners could have seen more skinks close to their homes because they likely spend more time in their yards, and therefore may be more likely to encounter prairie skinks there. Alternatively, prairie skinks may be more visible in short vegetation near human development.

Many landowners talked about landscaping in the form of tree planting and establishing gardens or flower beds. Landscaping activities such as these bring about changes in available habitat and facilitate the encroachment of non-native plants onto high quality native habitat (Merenlender et al. 2009). However, prairie skinks may not be negatively affected by all of these activities equally. Some prairie skinks were found by landowners and by myself in landscaped areas but this tended to occur in areas that were often older and somewhat overgrown. Three of the newer landowners in the area noted that they saw prairie skinks soon after they had built on the properties, but two of them had not seen other prairie skinks since then. Related skink species, such as the sand skink (*Plestiodon reynoldsi*), were found areas with sub-optimal habitat, indicating that habitat

structure may be suitable despite disturbance of native vegetation (Pike and Roznik 2009). Meanwhile, some landscaping elements such as well-established flower beds were places people saw prairie skinks regularly. The use of these areas by prairie skinks could indicate that they contain appropriate habitat structure, which may be more important to cryptic reptiles than the presence of native vegetation (Garden et al. 2007). Nonetheless, prairie skinks are using landscaped features in the absence of more natural habitat, which is evidence of prairie skink adaptability.

### *Threats to Prairie Skinks*

Threats to prairie skinks on private property occur on a different scale than on a larger property such as a provincial park. An important threat is the presence of outdoor cats. Most landowners only had one or two cats and some referred to outdoor cats as hunters. Landowners readily conceded that their cats had caught prairie skinks, which indicated that they did not perceive this to be a conservation concern, or that they did not believe they could do anything about the issue. Others believed that because they fed them, their cats would no longer hunt. However, there is evidence that domestic cats will hunt despite having a reliable alternative food source (Larsen and Henshaw 2001, Gillies and Clout 2003). Cats also hunt close to the home (Larsen and Henshaw 2001), which may be especially detrimental for prairie skinks using flower beds and cover close to houses and outbuildings.

Predation of endangered species by cats has been well documented. In particular, the introduction of cats to islands where predation pressure had previously been low, has been detrimental to many rare species (Faulquier et al. 2009; Medina and Nogales 2009;

Tocher 2006). For cryptic lizards like the prairie skink, increased predation pressure may force the lizards to seek refuge under cover materials more often (Cooper 1998). Seeking refuge may be detrimental physiologically because lizards rely on external temperatures for thermoregulation and cover materials may not provide optimal temperatures (Downes 2001). Additionally, lack of appropriate cover on manicured exurban properties may also lead to increased predation by cats. The combination of physiological trade-offs of seeking refuge more often, and lack of appropriate refuge makes prairie skink populations on exurban properties particularly vulnerable to predation pressure from cats.

On exurban properties, the lack of appropriate vegetation structure may also pose a direct threat to prairie skinks, especially if landowners mow large portions of property. Dividing properties into smaller acreages where a higher proportion of the property is manicured lawn may also be detrimental to prairie skinks. The effects of housing density remain contentious, with some arguing that high density and low density are both detrimental to the landscape depending on the development patterns (Pejchar et al. 2007). While there are some acreages in my study area were larger than 10 acres (4 ha), many were smaller, and depending on the landowner, the entire property may be mowed and landscaped. When conducting prairie skink surveys, I did not find prairie skinks in lawn habitat unless they were under a cover board (Chapter 3, this thesis). Larger properties in the area often had more unmanaged land. Landowners may be less likely to leave debris in plain sight and more likely to create a manicured landscape on a small property. This combination would not serve the prairie skink's biological needs (Chapter 3, this thesis). If landowners are aware of the habitat needs of the prairie skink, then they may be willing

to be less aggressive in their maintenance. Landowners were also generally accepting of the presence of prairie skinks, which may mean they are willing to incorporate habitat for them into their landscaping scheme.

### *Prairie Skink Conservation and Management*

In Manitoba, organizations such as Nature Conservancy of Canada and Manitoba Habitat Heritage Corporation sign conservation agreements with landowners, which then protects the habitat on the property from development and changes in land-use that would remove desirable habitat. Both organizations emphasize prairie habitats in their mandates. Since many of the acreages are small (<4 ha), it is likely not feasible to place conservation agreements on most of these properties (Tim Sopuck pers. comm.). More appropriate methods of conserving rare species, like the prairie skink, may be community-based monitoring or using a conservation development framework (Theobald et al. 2005). If landowners take on the task of monitoring prairie skinks on their own property and if the community takes on prairie skink conservation as a goal, it may not be necessary to use conservation agreements on individual properties.

The ecological implications of exurban development are often not taken into account before construction begins (Theobald et al. 2005). In southern Ontario, environmentally conscious towns in the GTA have maintained some ecological integrity despite development pressure from the surrounding area (Gilbert et al. 2005). However, the initial development in the GTA has already degraded the habitat in the area, so that the remaining habitat is more critically in danger of disappearing (Gilbert et al. 2005). Small parcels of high-quality habitat can exist on each property, but even small scale

removal of habitat on many of the properties can severely reduce the habitat available in the development overall (Theobald et al. 2005). In my study area, larger properties may have more “untouched” habitat remaining, and three landowners even purchased a 30 acre piece of land together with the intention of protecting it from development.

However, the continuing subdivision of other properties may lead to a reduction in prairie habitat across the region. Theobald et al. (2005) suggest that exurban developments should be planned with an emphasis on conservation of ecologically significant areas.

New developments could potentially be planned as “conservation developments” around prairie skink habitat, as long as economic and institutional means are in place (Pejchar et al. 2007). This would mean avoiding development in areas with high quality mixed-grass prairie suitable for prairie skinks, which may conflict with the current development trend of converting native prairie pasture into exurban residential subdivisions.

Community-based citizen science could encourage landowners to conserve habitat on their properties, and build on their interest in the prairie skink (Miller and Hobbs 2002). The Assiniboine Hills Conservation District has already successfully enlisted the help of landowners to survey prairie skinks on pasture land in the area (Devon Baete, pers. comm). A project could be developed based on the Save Our Skinks website, with a project leader in the local community to help keep development momentum. From that, a database of all prairie skink sightings on private land near Carberry could be developed and the information could be used to monitor the prairie skink population and promote stewardship. While all landowners said they would submit sightings, few actually did. However, developing a cohesive, local program may help build momentum.

Increasing prairie skink knowledge among landowners may also help with conservation efforts. A number of landowners indicated that they would do more for prairie skinks if they knew what to do, so landowner education could be an effective way of encouraging conservation and the submission of sightings. Many landowners had first heard of prairie skinks from a neighbour so providing information to local residents will encourage the spread of information by word of mouth, particularly to newcomers. There is a mix of new and old residents in these areas and some of the newest residents had minimal prairie skink knowledge. Landowners who were interviewed in the Carberry and Shilo regions of Manitoba were interested in knowing more about prairie skinks, thus providing more information about prairie skinks may help in conservation efforts.

Knowledge is not the only consideration when determining whether landowners will engage in conservation activities. Personal values and lifestyle will impact whether a person will engage in conservation activities. Raymond and Brown (2011) also found that gender, livelihood, income source and level of formal education affected the level of landowner engagement with environmental issues. Highly educated women who owned small hobby farms were more likely to be engaged than less educated men with highly agricultural backgrounds (Raymond and Brown 2011). Many of landowners in my study found employment away from home and own small parcels of land. Because their livelihoods are not tied directly to the land, the landowners are more likely to be engaged in conservation activities and habitat preservation is also likely to be higher.

## **Conclusion**

Prairie skinks appear to be found commonly on exurban properties near Spruce



Woods Provincial Park and CFB Shilo. These properties, while managed differently from publicly owned land, appear to have appropriate habitat despite extensive landscaping. Debris piles, and other cover such as flower beds and rock gardens, are crucial for the prairie skink's survival on these properties, particularly where pet cats pose a threat. Extensive mowing also poses a threat, and landowners should be encouraged to leave some native grassland. Landowners seem to have a neutral or positive attitude towards prairie skinks, which suggests that there is potential for prairie skink conservation on exurban land. Providing landowners with more information about the habitat needs and natural history of prairie skinks will increase interest and awareness as well as encourage conservation.

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## Tables

Table 1. Codes pertaining to land use, and landowner/property information

Primary code	Definition	Secondary code categories
Acres	Number of acres on property	
Activities	any activities, outside of land maintenance, that take place on the property	recreational activities, small scale agriculture, leaving the land alone
Cats	whether landowners owned pet cats	indoor, outdoor, skink predation, denial of damage by cats
Debris piles	existence debris piles of all kinds on the property	wood (natural or lumber), scrap, compost
Habitat types	types of habitat and features found on the property	grassland, bush, sandy soil, lowland/wetland, agricultural
Livelihood	general location of landowner's employment	retired, rural, in Brandon, or in Carberry, from home
Maintenance	Land maintenance activities	land clearing, weed control, mowing, burning, doing nothing, gardening, planting trees
Reasons	Reasons why a landowner moved to the property	country living, jobs, liked the area, liked the landscape, don't like the city
Time	How long they have lived at the location	

Table 2. Codes relating directly to prairie skinks

Primary code	Secondary code	Definition	Tertiary code categories
Encounters	type	description of ages, sizes etc of skinks encountered on property, nests, first encounter	
Encounters	frequency	how often skinks were seen on the property	never, rarely, sometimes, often
Encounters	habitat	types habitat on the property where skinks were seen	flowerbeds, rocks, boards, rail ties, human development, grasslands
Encounters	other categories	other encounter related information	while mowing, encounters during interview
Knowledge	appearance, behaviour habitat, food, tail	information given by landowner about skinks and their needs, appearances etc	
Knowledge	lack	Landowner expressed lack of information	
Knowledge	more	Landowner asked questions, wanted to know more about skinks	
Knowledge	first heard	when/how they first heard about skinks, found out what they were	
Attitudes	conservation	how they felt about conserving skinks or conservation in general	
Attitudes	enjoyment	expressed enjoyment, thought skinks were cute	
Attitudes	negative	found skinks gross or ugly	
Attitudes	neutral	neutral feelings, skinks were just there.	
Attitudes	willing	Landowners expressed willingness to participate	provide sightings, make habitat, would do something if they had more information, or would take precautionary measures to avoid habitat destruction or skink death

Table 3. Reasons given by participants for living at their location on an exurban/rural property.

<b>Reasons</b>	<b>% of participants*</b>
Wanted to escape the city or loved the country	60
Liked the landscape/area	31
Moved for work	29
Wanted to have more space	17
Wanted to own a property	14
Recreation opportunities	9
Not too far from the city	9
Other	9
Good water	9
Costs less to live in the country	3

\*Note: Some participants gave more than one reason

Table 4. Maintenance activities happening currently or previously on the property of the participant

<b>Activities</b>	<b>% of participants</b>
have flowerbeds and/or garden	80
mow a “small” lawn area, less than ¼	54
clear brush	37
plant trees	29
mow ½ to whole property	26
mow about ¼ to less than ½ property	17
mow brush/prairie as maintenance	14
Burn prairie as maintenance	6

Table 5. Ratings of yard and neighbourhood statements by percentage of total response. A rating of 1 is strongly disagree and 5 is strongly agree

<b>Statements</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Having a tidy yard is important to me.	0	3	26	29	4
Living in a tidy neighbourhood is important to me.	0	6	11	26	54
Leaving some native grassland/bush is important to me.	0	0	0	20	8
Having a mowed lawn increases the aesthetics of my property.	3	0	11	26	6

Table 6. Recreation and other activities that take place on the property

<b>Activities</b>	<b>% of participants</b>
Walking or hiking	57
Other	26
Snowmobile, quad, dirt bikes	20
Agriculture-horses	17
Sports	14
Swimming pool	11
Agriculture-chickens	6

Table 7. Results of quiz in which participants were asked to identify five local reptiles and one amphibian from photographs. Remaining participants did not know or confused the species with another.

<b>Species</b>	<b>Positive id (%)</b>
Northern Prairie Skink	86
Garter Snake	83
Tiger Salamander	49
Western Hognose Snake	34
Smooth Green Snake	31
Red Bellied Snake	3

Table 8. Habitat on private property where prairie skinks were encountered by participants.

<b>Habitat type</b>	<b>% of participants*</b>
Human	57
Debris/woodpile	40
Flower beds	37
Rail Ties	29
Soil	26
Rocks	23
Grassland	17
Road	6

\*Note: Some residents saw them in more than one habitat.

Table 9. Willingness of landowners to participate in conservation activities.

<b>Willing to:</b>	<b>% of participants</b>
Report sightings	100
Do things to prevent death/destruction	31
Do something if they knew what to do	23
Make habitat	14



## Figures

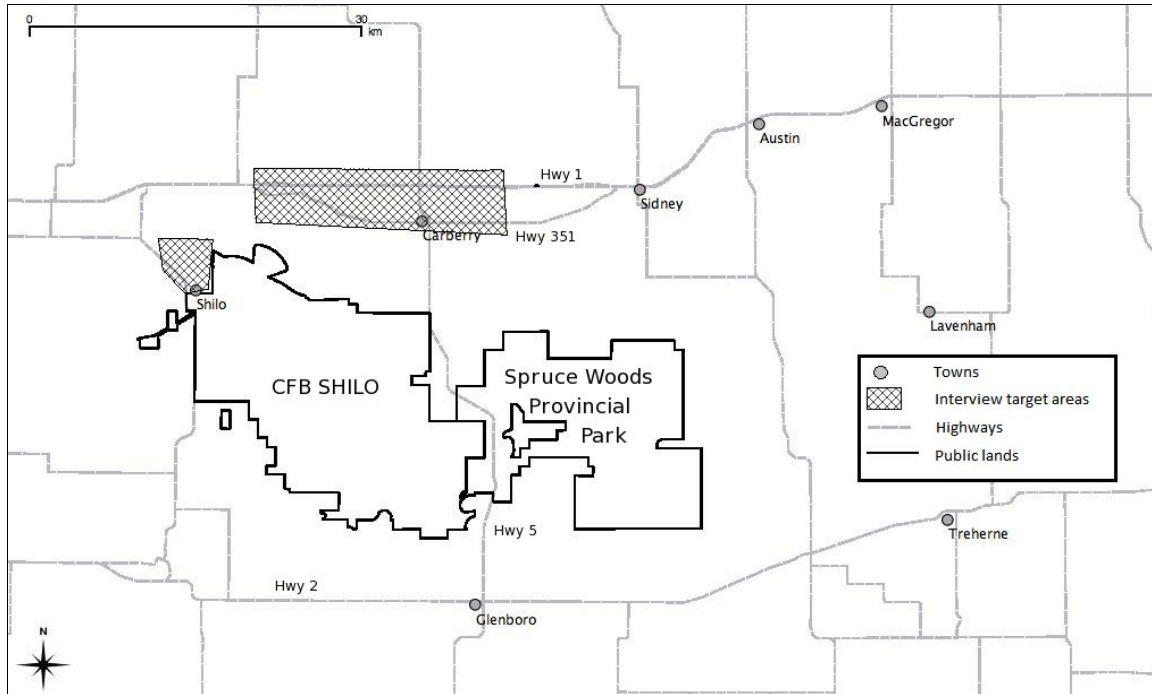


Figure 1. Target area for interviews near the towns of Shilo (west) and Carberry (north), Manitoba (base layers from Manitoba Land Initiative).

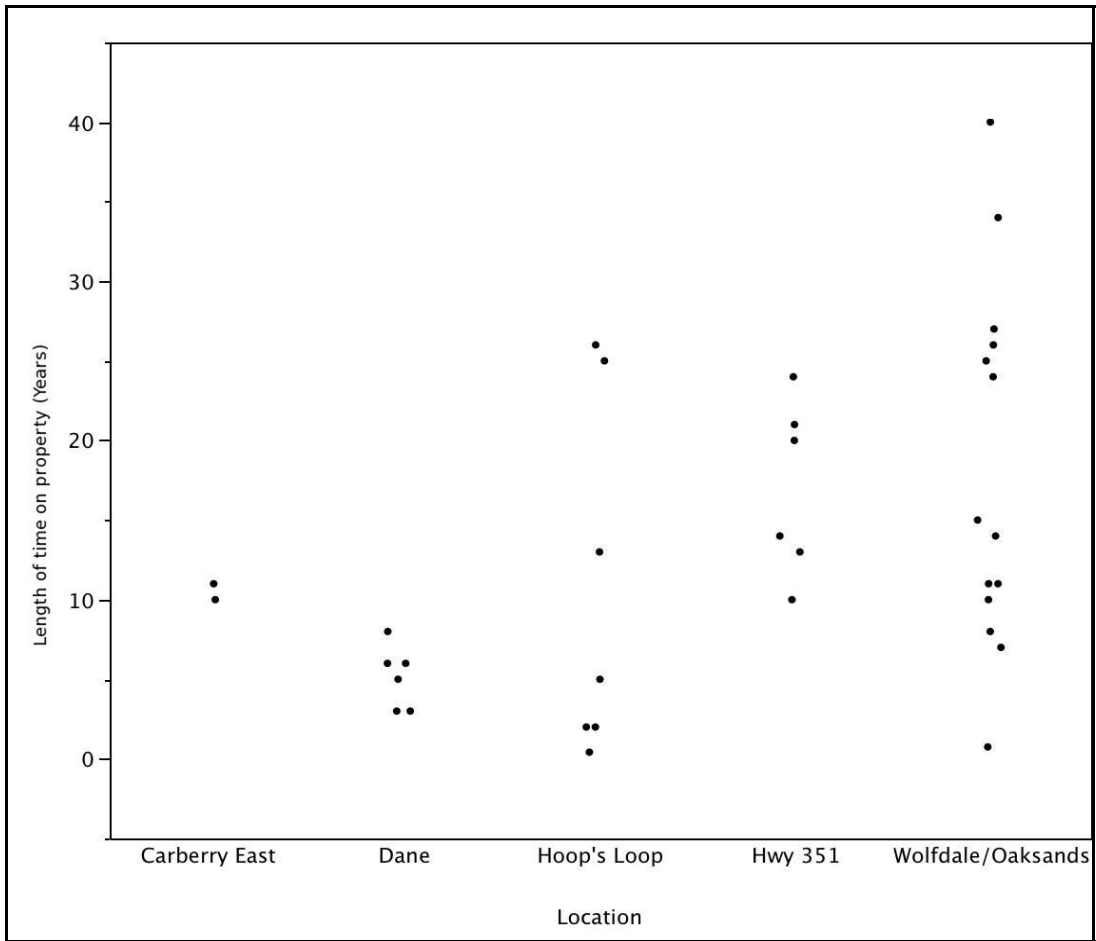


Figure 2. Length of time participants have lived on their property. Data separated into localities.

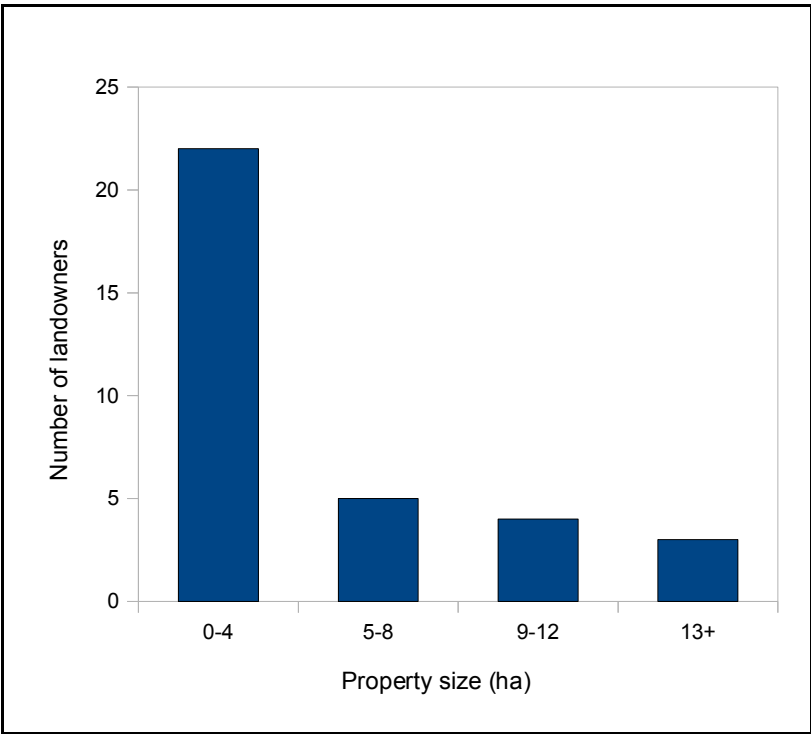


Figure 3. Number of participants residing on different sizes of properties, in hectares.

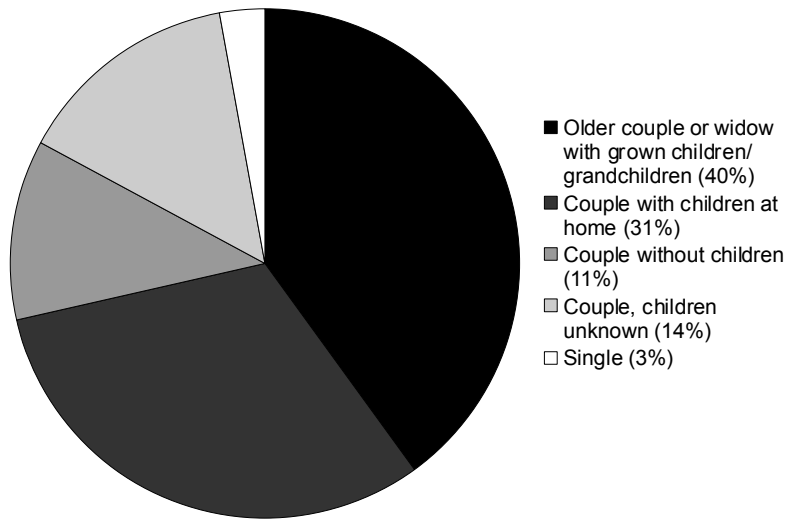


Figure 4. Demographics of participants, in broad categories.

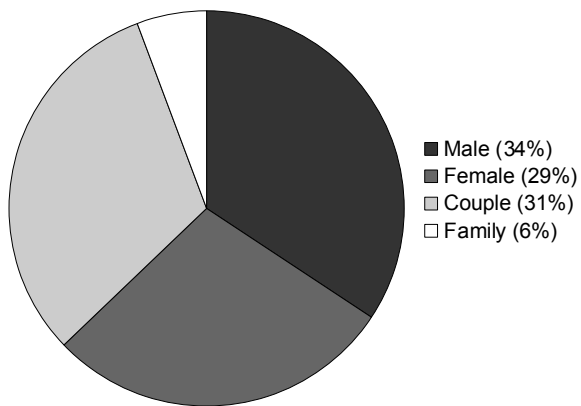


Figure 5. Demographics based on who participated in the interviews.

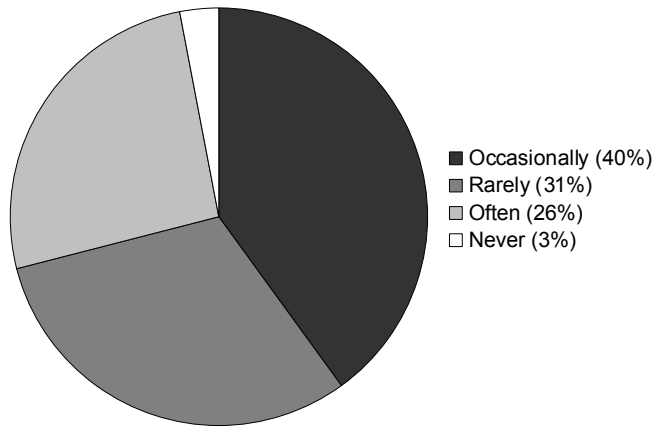


Figure 6. Frequency of prairie skink encounters by participants.

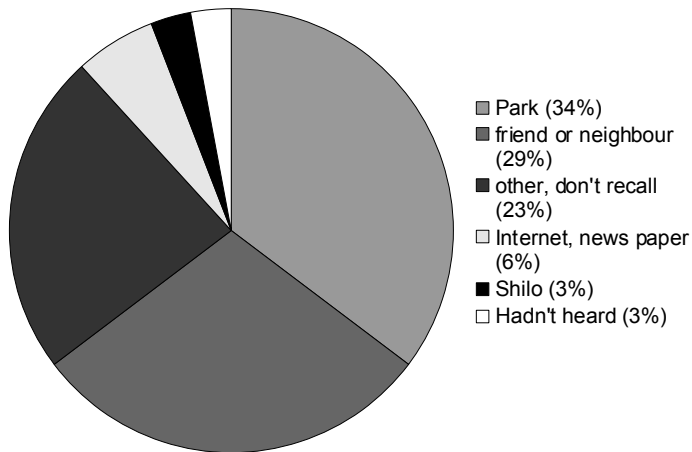


Figure 7. Where landowners had first heard about prairie skinks.



Figure 8. Photo of a prairie skink found in a paving stone crevice right next to a garage, on a private property.



Figure 9. Overgrown flower bed bordered by rail ties and a mowed lawn. A common place to find prairie skinks on private properties.

## **CHAPTER 6. CONCLUSIONS AND MANAGEMENT IMPLICATIONS**

Conservation of endangered species is difficult if only public lands are protected and managed. Management also needs to occur on private lands, but to do this landowners need to be engaged. By incorporating data from both expert-based prairie skink surveys and landowner sightings, I have gained a more complete picture of prairie skink conservation on private land. During the prairie skink surveys I determined that vegetation heterogeneity and thermal variation are important aspects of prairie skink habitat. Additionally artificial cover plays a role in supporting higher populations of prairie skinks on small properties. However, I found prairie skinks in mixed-grass prairie habitat almost exclusively. Those areas were the largest and took more time to survey than the smaller patches of lawn and garden. During the interviews some landowners indicated that they spent much of their time in their yards and very little time walking out on the prairie. Thus they were more likely to encounter prairie skinks in their gardens and near buildings. By combining visual encounter surveys with landowner observations, it became clear that prairie skinks are encountered in many different areas on private property, from highly developed outbuildings and landscaped areas to unmanaged mixed-grass prairie. Using quantitative or qualitative data alone may have lead to the conclusion that prairie skinks are habitat specialists when clearly they are not.

While some endangered species are sensitive to habitat disturbance, prairie skinks appear to be generalists in their microhabitat preferences. Prairie skinks are often found in healthy native grassland in Spruce Woods Provincial Park and at CFB Shilo, but they are also likely to be found in non-native habitat existing on private land. Prairie skinks



were observed in debris-filled pastures, in overgrown flower beds surrounded by manicured lawn, in scrap wood piles, under landscaping rocks, and even escaping into a crack in the foundation of an outbuilding. Landowners also told me of sightings in their yards, and very close to their homes. Prairie skinks are clearly adaptable to habitat other than native mixed-grass prairie and this adaptability should be accounted for when developing recovery plans and designating critical habitat for the species. If small areas of prairie habitat remain on exurban properties, it may be augmented with artificial cover to potentially increase prairie skink populations in the area and make them easier to monitor.

Incorporating prairie skink habitat use on private land into conservation strategies is not simple. The federal Species at Risk Act does not protect species or habitat on private property and prairie skinks are not yet listed under the Manitoba Endangered Species Act (MB ESA). The Manitoba legislation would afford some protection to the prairie skink as it is relevant to management on both public and private lands. However, it would be problematic to enforce such legislation. Cats would pose a significant problem when enforcing MB ESA legislation because many landowners have seen their cats catch and kill prairie skinks but they are not likely to refrain from owning cats. Legislating the control of outdoor pet cats in rural municipalities would be difficult and likely controversial, but perhaps some legislation for feral cat populations would help the situation. The other problem with legislating protection for prairie skinks on private land is that people may harm prairie skinks unintentionally. One woman accidentally killed a prairie skink in her garden, while others have dug them out of sand piles and

unknowingly disturbed nesting sites. Prairie skinks are so small that sometimes harming them can go unnoticed. It would be difficult to charge people under the legislation for that reason alone.

Another way to protect prairie skinks is to protect existing habitat via conservation agreements. Manitoba Habitat Heritage Corporation and Nature Conservancy both enter into conservation easement agreements with willing landowners, which protect private land from development and therefore would protect grassland habitat. These conservation agreements would be useful but they are only available to landowners with properties that are at least 16 ha in size. All but one of the properties I visited were far smaller than that. Instead of targeting the exurban developments already in place, it may be more effective to focus conservation agreements on the rural areas surrounding these developments. By focussing on these areas, conservation organizations can protect the land from very small subdivisions, and also from conversion of prairie to potato farms, both of which could be detrimental to skink populations.

Landowners in the areas I studied generally did not develop large portions of their property, especially those landowners with 4 ha or more, and therefore large portions of the property remained undeveloped. It is also important to note these properties are not being used for intensive agriculture and thus, there is often native prairie habitat remaining. On the smaller properties (2-4 acres) it is more likely that landowners will mow a higher proportion of the property, which reduces vegetation structure and leaf litter from taller grasses, and thus reduces skink habitat. Landowners with small, open properties are also likely to plant more trees and shelterbelt shrubs, which may not be

ideal for skinks. During the course of this study, some of the native prairie pasture land in the area was being subdivided into more exurban lots, so perhaps writing lot size restrictions related to prairie skink conservation into the development policies at the Rural Municipality level may be helpful in furthering conservation goals of the area.

One way to encourage conservation of prairie skinks on private land is to educate and engage the landowners. Almost all the landowners I talked to asked me many questions about prairie skinks. If they know about them they might be more likely to a) create habitat by leaving some scraps of wood on their property, b) be more careful when landscaping, so as not to harm prairie skinks, and c) appreciate prairie skinks as part of the local fauna. Motivation may be a barrier, but having a cohesive project coordinated locally by an individual or small group may be effective. Prairie skinks are unique to the area, and so if the landowners know more about them, they may tell their neighbours and friends about them and the knowledge will spread. Many had first heard of prairie skinks from their neighbours as it is. Engaging the towns of Carberry and Glenboro to promote prairie skinks might foster even more appreciation for prairie skinks and the local landscape. My study also showed that many prairie skinks can be found on small properties that have abundant cover. Thus, promoting the use of artificial cover material, which is already present on many properties, may help prairie skink populations in the area. Many landowners already appreciate the local landscape and fauna. It is therefore imperative to maintain involvement of the local people in prairie skink research.

Future prairie skink conservation research should focus on the role of cover in predator avoidance, particularly in the case of house cat predation. While my study found

that landowners had observed their cats capturing prairie skinks, I did not measure the frequency of cat predation or the survival rate of prairie skinks after predation attempts. It may also be useful to study the use of flowerbeds and gardens to attempt to understand how prairie skinks use these habitats, as I did not personally observe many prairie skinks in these areas. While landowners told me where they had encountered prairie skinks, there was no way to gauge population size or reproductive success. A future study would be necessary to determine whether prairie skinks are breeding on highly developed properties and if they are using gardens or other habitat (i.e. debris piles) to do so. Visual encounter surveys were too brief to be able to capture prairie skinks in gardens, so perhaps an observational approach, where one spends a lot of time in one location, would be more effective. While information from landowners is very useful, one drawback is the lack of consistency between landowner observations. One landowner may remember every prairie skink they saw on the property and another might vaguely remember seeing prairie skinks once or twice. It maybe helpful in future studies to organize a small group of keen landowners and encourage them to be vigilant while looking for prairie skinks on their properties.

While these recommendations are specific to prairie skinks, there are applications to other endangered species on exurban land. These properties are not being used for agriculture and most landowners do not earn livelihoods on their land. Often they choose to live on exurban land because they want to be close to nature, and thus they are amenable to conservation activities. Rare species of plants and animals that are geographically limited but are locally abundant, like the prairie skinks, may thrive on

these properties. They may even evoke feelings of pride in the landowners whose properties harbour these species. While it seems as though development and rare species cannot coexist, there are cases where the right level of development can work. However, it is important to note that a) landowners need to be aware that they have the species on their property, and b) there needs to be enough information available about the species in question to be able to determine what level of development may be tolerated.

## **APPENDIX 1: ETHICS APPROVAL**

## APPENDIX 2: PRAIRIE SKINK CAPTURE DATA

Property	Total survey time (person hours)		Total	Captures		Habitat Types		
	Garden and lawn	Prairie		Open	Under cover	Prairie	Garden	Lawn
Hwy 351 A	1.17	6.03	10	1	9	10	NA	0
Hwy 351 B	1.43	7.3	5	2	3	5	0	0
Worby	2.3	4.38	6	1	5	0	NA	6
Lavenham A	1.02	4.85	5	4	1	5	0	0
Lavenham B	1.1	6.45	16	5	11	16	0	0
Glenboro A	1.53	3.23	13	3	10	13	0	0
Glenboro B	0.53	3.15	3	0	3	3	NA	0
Hoop's Loop	2.42	3.35	1	1	0	1	NA	0
Total	11.5	38.74	59	17	42	53	0	6
Average	1.44	4.84	7.38					

Property	Age				Sex		
	Adults	Juveniles	YOY	Unknown	Males	Females	Unknown
Hwy 351 A	7	0	1	2	5	2	3
Hwy 351 B	5	0	0	0	5	0	0
Worby	4	2	0	0	2	0	4
Lavenham A	2	1	0	2	1	0	4
Lavenham B	4	3	8	1	3	1	12
Glenboro A	7	2	4	0	3	0	10
Glenboro B	2	1	0	0	1	1	1
Hoop's Loop	1	0	0	0	1	0	0
Total	32	9	13	5	21	4	34

## APPENDIX 3 : INTERVIEW SCHEDULE

### Phone Call Script

Hi \_\_\_\_\_, I'm a student from the U of M and I'm conducting research on small lizards called prairie skinks, found in the Carberry/Shilo area. I was wondering if you would be willing to participate in a short (20-30 min) interview, to contribute information to my master's thesis research

### Interview Schedule

*Is it ok with you if I record this interview? Y/N*

#### **Land use- First I'd like to ask you a few questions about your land.**

1. How many acres is your lot?
2. How long have you lived here?
3. What were your reasons for moving to/living at this location?
4. What were the historical uses?
5. What do you do for a living?
6. Which activities take place on your land?
  - ⤴ Gardening
  - ⤴ Hiking
  - ⤴ Small scale agriculture (horse, chickens etc)
  - ⤴ Other \_\_\_\_\_
7. Do you have pets?
  - Dogs \_\_\_ Cats \_\_\_ others \_\_\_\_\_
  - ⤴ What percentage of time do they spend outdoors? Indoors?
8. What kinds of things do you do to maintain your property? (*thinning brush, burning, weed control, etc*)
9. Do you mow any part of your property? How much of your property do you mow?
10. Which habitats are found on your property? Proportions?
  - ⤴ Flower beds/Gardens
  - ⤴ Native grassland
  - ⤴ Bush
  - ⤴ Other \_\_\_\_\_
11. Do you have any debris piles on your property? Wood piles? Where?
12. How many buildings and what types (house, garage, sheds) do you have?
13. Rate whether you agree or disagree with the following statements: (1 strongly disagree, 2 disagree, 3 neutral/don't know, 4 agree, 5 strongly agree)
  - ⤴ Having a tidy yard, free of debris and overgrown vegetation, is important to me. 1 2 3 4 5



- ⤴ Living in a well maintained, tidy neighbourhood is important to me.  
1 2 3 4 5
- ⤴ I value leaving some native bush and grassland on my property. 1 2 3 4 5
- ⤴ Having a mowed lawn area increases the aesthetics of my property.  
1 2 3 4 5

### **Reptile and Skink Awareness**

1. Do you recognize any of these reptiles or amphibians (*show photos of skink, garter, hognose, salamander, smooth green, red belly- see following page*)? Can you name them? Do you know which one is the prairie skink? (*point out prairie skinks*)
2. Have you ever seen skinks or any of the other reptiles I showed you on your property?
3. Had you heard about prairie skinks before we met? *Y/N (if no go to question 7)*
  - ⤴ Where did you hear about them?
  - ⤴ What do you know about them? *Habitat, food, other characteristics...*
4. How often do you see prairie skinks on your land? *1 never, 2 rarely (one per season), 3 sometimes (a couple times per year), 4 often (a few times a month during summer), 5 very often (almost daily)*. If never, skip to question 6.
5. If 2-5, what time of year do you see them most often? *May/June, July, August/September*
  - ⤴ How many years have you observed them here? What time of day? Weather?
  - ⤴ Where? (map, walkabout) (*Once this interview is over, can we go walk around your property so you can show me?*)
6. Have you ever seen skinks or the other reptiles elsewhere? Where?
7. Do you have children living at home (or grandkids)? Do they ever find skinks or other reptiles?
8. Prairie skinks on the endangered species list in Canada.
  - ⤴ When you hear this, what thoughts come to mind? (*getting at perceptions of species at risk*)
  - ⤴ Do you know of any other rare or endangered plants or animals in the area?
  - ⤴ If you had an endangered species on your land, how would you feel about that?
9. If you had prairie skinks on your property change how you manage or maintain it? *Or Does having prairie skinks on your property change...*
10. Would you be interested in providing us with information about skinks on your land in the future?
  - ⤴ What, if anything might hold you back from doing this?
11. Before we finish, do you have anything else to add regarding your land or reptile conservation? Do you have any questions?
12. Do you wish to be contacted about skink research in the future? (*only if they have skinks*)