

# Recovery Strategy for the Greater Short-horned Lizard (*Phrynosoma hernandesi*) in Canada

## Greater Short-horned Lizard



2015



Government  
of Canada

Gouvernement  
du Canada

Canada

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<sup>1</sup> <http://www.registrelep-sararegistry.gc.ca>

## Preface

The federal, provincial, and territorial government signatories under the [Accord for the Protection of Species at Risk \(1996\)](#)<sup>2</sup> agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress five years after the publication of the final document on the SAR Public Registry.

The Minister of the Environment and Minister responsible for the Parks Canada Agency is the competent minister under SARA for the Greater Short-horned Lizard and has prepared this recovery strategy, as per section 37 of SARA. To the extent possible, it has been prepared in cooperation with the governments of Alberta and Saskatchewan and Agriculture and Agri-Food Canada.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Environment Canada and Parks Canada Agency, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Greater Short-horned Lizard and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment Canada and Parks Canada Agency and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

The recovery strategy sets the strategic direction to arrest or reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all Canadians with information to help take action on species conservation. When the recovery strategy identifies critical habitat, there may be regulatory implications as SARA sets out a process to evaluate existing protection mechanisms under other Acts of Parliament and provincial and territorial legislation, and if necessary, to put in place additional protection under SARA. For critical habitat located on federal lands outside of federal protected areas the Minister of the Environment must either report on existing legal protection or make an order to provide protection. The Minister of the Environment will assess whether critical habitat is effectively protected on non-federal lands. The discretion to protect critical habitat that is not effectively protected rests with the Governor in Council.

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<sup>2</sup> <http://registrelep-sararegistry.gc.ca/default.asp?lang=en&n=6B319869-1#2>

## **Acknowledgments**

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## Executive Summary

The Greater Short-horned Lizard (*Phrynosoma hernandesii*) is a small flattened lizard with a single row of white projecting scales fringing the edge of the body. It has a broad head with short stubby 'horns' that are separated at the center by a wide indented notch. Dorsal colouration varies slightly by region and is highly cryptic. The Greater Short-horned Lizard ranges throughout the Northern Great Plains as far south as central Mexico. In Canada, known populations are located in south-eastern Alberta and southwest Saskatchewan.

Greater Short-horned Lizard habitat is limited to areas lying between upland grassland and coulee bottoms and consists of rugged, sparsely vegetated slopes. The species also requires crumbly, well-drained soils which are important for overwintering as well as refuge during the night when they often burrow underground for thermal insulation.

The Greater Short-horned Lizard was designated Endangered in Canada in 2007 due to ongoing threats and its small and fragmented distribution in Canada. Threats faced by the Greater Short-horned Lizard include: conversion of native habitat to industrial infrastructure, creation of roads in native habitat, dams and irrigation development, conversion of native habitat to crop and forage production, invasion and establishment of exotic plants, inclement or extreme weather conditions, mortality from traffic and pets due to urban expansion, mortality from oil spills, and collection.

There are four general areas in Alberta and four general areas in Saskatchewan where local populations of Greater Short-horned Lizards are known to occur. There are likely additional local populations where suitable habitat exists but there have been no or insufficient survey efforts.

Recovery of this species is biologically and technically feasible. The population and distribution objective for the Greater Short-horned Lizard is to maintain populations in all of the critical habitat polygons within the 8 currently known areas of occupancy of the species plus any new populations discovered in the future. Broad strategies to achieve recovery include: (1) habitat assessment, management, conservation and protection; (2) monitoring and assessment; (3) research; and (4) communication, collaboration and engagement.

Critical habitat for the Greater Short-horned Lizard, is partially identified to the extent possible in southeast Alberta and in southwest Saskatchewan based on best available information on historical and recent site occupancy of lizards and habitat suitability. The critical habitat that is identified in this recovery strategy for the Greater Short-horned Lizard occurs within 539 quarter sections<sup>3</sup>.

One or more Action Plans for the Greater Short-horned Lizard will be completed by 2018.

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<sup>3</sup> A quarter section is a parcel of land 64 ha (160 acres) in size.

## Recovery Feasibility Summary

Under the *Species at Risk Act* (Section 40), the competent minister is required to determine whether the recovery of the listed species is technically and biologically feasible. Based on the following criteria established by the Government of Canada (2009) for recovering species at risk, recovery of the Greater Short-horned Lizard is considered to be technically and biologically feasible:

**1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.**

Yes. There are numerous areas where Greater Short-horned Lizards are known to be successfully reproducing. Small clusters of individuals have persisted for decades suggesting long-term occupancy is possible even when local population size is small (L. Powell pers. comm. 2012).

**2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.**

Yes. Existing occupied habitat is considered to be in suitable condition and is sufficient to support the species. In addition, many other areas of apparently-suitable habitat are currently unoccupied. Amount of suitable habitat is not considered to be limiting for this species.

**3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.**

Yes. The conversion of native habitat to industrial infrastructure in Greater Short-horned Lizard habitat can be avoided or its effects can be mitigated. Appropriate land use planning can also manage the impact of road development.

**4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.**

Yes. Recovery techniques are available to conserve and protect habitat, promote habitat stewardship, and support public education in order to decrease effects of important threats to the Greater Short-horned Lizard.

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## 1. COSEWIC\* Species Assessment Information

**Date of Assessment:** April 2007

**Common Name (population):** Greater Short-horned Lizard

**Scientific Name:** *Phrynosoma hernandesi*

**COSEWIC Status:** Endangered

**Reason for Designation:** In Canada this species exists in less than 10 scattered locations that are severely fragmented. Most of these populations are threatened by ongoing oil and gas development, proliferation of roads, proposed mineral development, and an increasing human presence.

**Canadian Occurrence:** Alberta and Saskatchewan

**COSEWIC Status History:** Designated Special Concern in April 1992. Status re-examined and designated Endangered in April 2007.

\* COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

## 2. Species Status Information

The Greater Short-horned Lizard (*Phrynosoma hernandesi*, Girard 1858) has a global status of secure (G5, NatureServe 2013). The species is also considered secure (N5) in the United States and its status ranges from imperiled to secure (S2 to S5) within the 11 states that it occurs (NatureServe 2013). No conservation status has been applied in Mexico (NOM 2001). The International Union for Conservation of Nature (IUCN) has ranked the Greater Short-horned Lizard as least concern with a stable population trend (IUCN 2010).

In Canada, the Greater Short-horned Lizard was listed as Endangered under the *Species at Risk Act* (SARA) in April 2007. The species is designated as imperiled/vulnerable (N2N3) in Canada, imperiled in Alberta (S2) and imperiled/vulnerable (S2/S3) in Saskatchewan (NatureServe 2013). The species is listed as endangered by the province of Alberta, but it is not listed by the province of Saskatchewan. The Canadian range represents a small (<5%) proportion of the global range for this species (COSEWIC 2007), but it is likely less than 1%.



### 3. Species Information

#### 3.1 Species Description

The Greater Short-horned Lizard is a small (50-70 mm), exceptionally cryptic, flat and wide-bodied lizard with short legs and many short horns on its head and body that give this species its common name (Powell and Russell 1985, Sherbrooke 2003). Dorsal colouration can be tan, yellow-brown, orange-brown, or reddish-brown depending upon the animal's surroundings since camouflage is the primary means of protection against predators (Alberta Sustainable Resource Development [ASRD] 2004, COSEWIC 2007). Greater Short-horned Lizards exhibit marked sexual dimorphism, with females growing considerably larger than males.

The Greater Short-horned Lizard is sometimes referred to as “Horny Toad” because of its round and stubby appearance and waddling gait (COSEWIC 2007), however, it is a reptile and it is the only lizard that occurs in Alberta and Saskatchewan. The Greater Short-horned Lizard, like other reptiles, regulates its body temperature by moving between sunny and shaded areas. However, unlike most lizards, the Greater Short-horned Lizard does not lay eggs, but rather, gives birth to up to 15 live young that begin to live independently shortly after birth (Sherbrooke 2003).

Greater Short-horned Lizards have been observed on the soil surface as late as the beginning of November, although most lizards appear to be below the surface by mid-September (Powell and Russell 1994, 1996, Fink unpubl. data). Greater Short-horned Lizards emerge in late April from overwintering sites and courtship and mating occurs shortly thereafter.

The predator defense strategy of the Greater Short-horned Lizard, remaining immobile, makes them particularly vulnerable to human harassment.

#### 3.2 Population and Distribution

Greater Short-horned Lizards are endemic to and are widely distributed in the west-central arid and semi-arid grasslands and deserts of North America (Figure 1); extending throughout the Great Plains from the provinces of Chihuahua and Durango of south central Mexico north to the southernmost portions of the Canadian prairies (Russell and Bauer 2000, Sherbrooke 2003, Stebbins 2003, Hammerson 2007). There have been no known recent large-scale changes in the range of the species, which is believed to encompass between 200 000 – 2 500 000 km<sup>2</sup> (NatureServe 2013). The true size of the range is difficult to define due to the patchy nature of the occurrence of this species, such that only a small portion of the total area is occupied. Of the 17 species within the genus *Phrynosoma*, the Greater Short-horned Lizard is the most widely distributed in terms of altitude and latitude and in terms of overall range (Sherbrooke 2003, Leaché and McGuire 2006).



**Figure 1.** North American range of the Greater Short-horned Lizard (adapted from Hammerson 2007).

In Canada, Greater Short-horned Lizards are found in extreme southeast Alberta and extreme southwest Saskatchewan (Figure 2). This represents the northern limit of its range where its distribution and abundance are limited by the cold climate (Sherbrooke 2003).

Greater Short-horned Lizards occur in four disjunct areas in southeast Alberta comprising approximately 2 162 km<sup>2</sup> (Figure 2). These areas are: 1) the South Saskatchewan River valley (~639 km<sup>2</sup>); 2) the Chin Coulee/Forty Mile Coulee Complex (~231 km<sup>2</sup>); 3) the area east and south of Manyberries in the Pakowki Lake drainage (~387 km<sup>2</sup>); and 4) the valleys of the Milk River and Lost River (~905 km<sup>2</sup>) (Powell and Russell 1998, ASRD 2004). The largest area of continuous occupied habitat in Alberta is found south and east of the town of Manyberries along the southern fringe of the Cypress Hills (Powell and Russell 1998). Recent survey data indicates this region continues to support the largest population of Greater Short-horned Lizards in Alberta (ASRD 2004). There has been some reduction in the Alberta range (COSEWIC 2007).

Greater Short-horned Lizards occur in four disjunct areas of known occupancy in southwest Saskatchewan within and near Grasslands National Park, comprising approximately ~295 km<sup>2</sup> (Figure 2). These areas are: 1) the northern portion of the West Block of Grasslands National Park (~192 km<sup>2</sup>); 2) the central portion of the West Block of Grasslands National Park (~33 km<sup>2</sup>); 3) the southern portion of the West Block of Grasslands National Park (~11 km<sup>2</sup>); and 4) the southern portion of the East Block of Grasslands National Park (~58 km<sup>2</sup>).

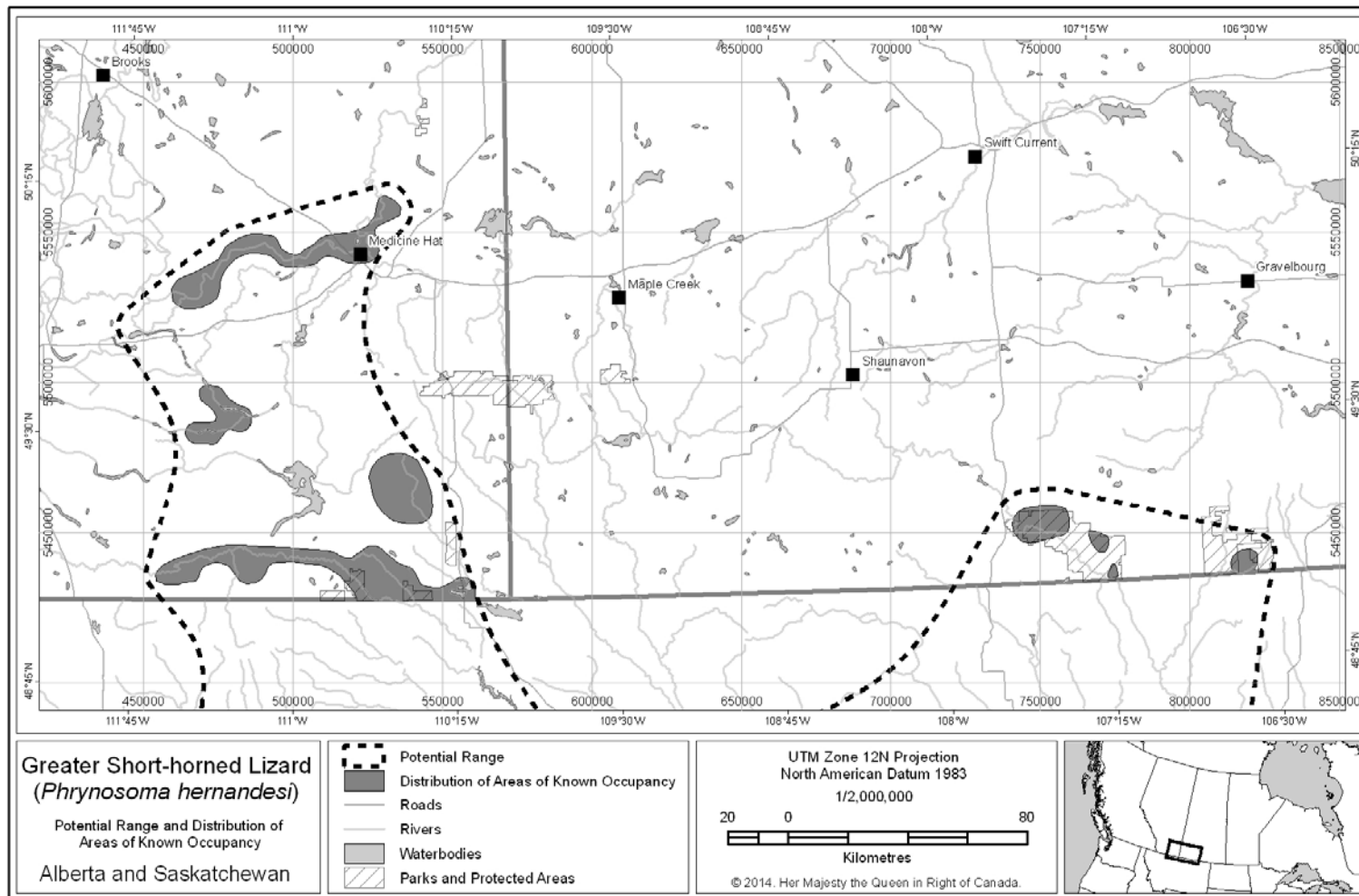
### ***Canadian population size and trends***

Population size for Greater Short-horned Lizards has been estimated in the four areas of occupancy in Alberta (ASRD 2004) using best available information from surveys conducted in 2001-2002. These estimates generated a total population size of 2,651 – 16,060 mature lizards for Alberta.

This population estimate is very tentative due to uncertainties of the proportion of suitable habitat which is occupied, and the actual densities of lizards within suitable habitat. These uncertainties arise from the small proportion of apparently suitable habitat which has been searched and the cryptic appearance and behaviour of the lizards, resulting in an unknown, but likely low, detection of presence during surveys.

In Saskatchewan there is also very limited information to determine population size, although it has been postulated that Greater Short-horned Lizard numbers may be lower than in Alberta (Powell et al. 1998). Surveys in the West Block of Grasslands National Park from 2008 – 2011 generated a population estimate of 5,200 – 8,320 mature individuals (K. Fink, unpub. data). This estimate is also very tentative due to the same uncertainties ascribed to the Alberta population estimate above.

Although it has been postulated that the Alberta population trend may be stable or declining, there is inadequate population information for either Alberta or Saskatchewan to evaluate population trend (COSEWIC 2007).



**Figure 2.** The potential range and distribution of areas of known occupancy of the Greater Short-horned Lizard in Canada. The known range in Alberta is comprised of four widely disjunct areas of known occupancy. The known range in Saskatchewan is comprised of four disjunct areas of known occupancy in and near Grasslands National Park. Additional localized areas of suitable habitat occupied by lizards may occur within the depicted potential range.

### 3.3 Needs of the Greater Short-horned Lizard

Throughout its range, the Greater Short-horned Lizard can be found in a variety of habitats including semiarid plains, shortgrass prairies, sagebrush deserts, shrubby plateaus, badlands, juniper, pine or fir forests, and in some mountainous areas (Sherbrooke 2003). In Canada, Greater Short-horned Lizards inhabit sparsely vegetated, south-facing slopes along eroded coulees, canyons, badlands, and ravines (Powell 1982, Powell and Russell 1985b, 1998, James 2002). Friable (crumbly, loose) soils or other penetrable substrates are important for overwintering as well as during the night when they burrow underground for thermal insulation. The dry badlands inhabited by the Greater Short-horned Lizard are characterized by low levels of precipitation, dramatic daily and seasonal temperatures changes, and high wind speeds (COSEWIC 2007).

Greater Short-horned Lizards inhabit the sparsely vegetated interface between upland grassland and coulee bottoms, particularly on south-facing slopes (Powell and Russell 1998, James 2002). These habitat characteristics occur in three different situations in Alberta: 1) the ecotone between upland prairie and coulee bottoms primarily in the Milk River Basin; 2) the rims of canyons and coulees with southern exposures in the northern marginal habitat along the South Saskatchewan River; and 3) Bearpaw shale dunes stabilized by mats of Creeping Juniper (*Juniperus horizontalis*) in the south perimeter of the Cypress Hills plateau and east of Manyberries, Alberta .

Bearpaw shale dunes stabilized by mats of Creeping Juniper are also the primary habitat for Greater Short-horned Lizards in Saskatchewan ( Powell and Russell 1995, 1998, James 2002). The association of Greater Short-horned Lizard occurrences with Bearpaw shale habitat in Grasslands National Park suggests this substrate is important for persistence of lizard populations (Powell et al. 1998).

Greater Short-horned Lizards require certain micro-habitat characteristics for their thermal, foraging and shelter requirements. Their body size and shape make moving through dense vegetation difficult. Sparse vegetation provides intermittent shade and full sun for thermoregulation. While the majority of Greater Short-horned Lizard observations are on south-facing slopes, they occasionally can be found on east, west, and some north-facing slopes if sites with suitable microclimates are present (James 1997, James 2002, K. Fink unpubl. data).

The amount of space required by individual Greater Short-horned Lizards is generally small and they typically occupy small centers of activity. They occasionally move several hundred meters among these centers of activity, usually by a few larger-distance movements rather than a single movement (J. James pers. commun. 2012, K. Fink unpb. data). Greater Short-horned Lizards are not territorial and overlap between individual home ranges is not uncommon (Powell and Russell 1993, 1996, James 1997, K. Fink unpubl. data).

Greater Short-horned Lizards forage on a variety of invertebrates; ants, beetles, and grasshoppers are major components of their diet. Prey items typically do not exceed 6 mm in length (Powell and Russell 1984).

In Canada, Greater Short-horned Lizards exist at the northern limit of their range and therefore experience more extreme winter conditions during the hibernation period (e.g. longer duration, lower temperatures, greater snow depth and depth of frost) than they do in more southern localities. Greater Short-horned Lizards overwinter approximately 10 cm beneath the soil surface (L. Powell pers. comm. 2012). This behavior enables them to survive during periods of low winter temperatures which are thought to limit the northern distribution of the species. Overwintering sites are typically erosional wash banks with steep slopes, vegetation overhangs, and soft substrates (Powell and Russell 1994, Mathies and Martin 2008). This species may prefer south-facing slopes for overwintering (COESWIC 2007) but this was not observed in Grasslands National Park (K. Fink, unpubl. data). Overwintering lizards require adequate snow cover. Inadequate insulation during hibernation due to limited snow accumulation may contribute to overwintering mortality (Powell and Russell 1994, 1996).

## 4. Threats

### 4.1 Threat Assessment

Table 1. Threat Assessment Table

Threat	Level of Concern <sup>a</sup>	Extent	Occurrence	Frequency	Severity <sup>b</sup>	Causal Certainty <sup>c</sup>
<b>Habitat Loss or Degradation</b>						
Conversion of Native Habitat to Industrial Infrastructure	Medium	Widespread	Current	Continuous	Medium	Medium
Creation of Roads in Native Habitat	Medium	Widespread	Current	Continuous	Medium	Medium
Dams and Irrigation Development	Low	Localized	Historic/ current	One-time	Low	Low
Conversion of Native Habitat to Crop and Forage Production	Low	Localized	Historic/ Current	Continuous	Low	Medium
High-intensity Prolonged Grazing	Low	Localized	Current	Seasonal	Low	Low
<b>Changes in Ecological Dynamics or Natural Process</b>						
Invasion and Establishment of Exotic Plants	Low	Widespread	Current	Continuous	Low	Low
<b>Climate and Natural Disasters</b>						
Inclement or Extreme Weather Conditions	Low	Widespread	Anticipated	Continuous	High	Low

<b>Accidental Mortality</b>						
Mortality from traffic, and from pets due to urban expansion	Low	Localized	Current	Seasonal	Low	Medium
<b>Pollution</b>						
Mortality from Oil Spills	Low	Localized	Current	Continuous	Low	Low
<b>Biological Resource Use</b>						
Collection	Low	Localized	Current	Seasonal	Low	Low

<sup>a</sup> *Level of Concern: signifies that managing the threat is of (high, medium or low) concern for the recovery of the species, consistent with the population and distribution objectives. This criterion considers the assessment of all the information in the table.*

<sup>b</sup> *Severity: reflects the population-level effect (High: very large population-level effect, Moderate, Low, Unknown).*

<sup>c</sup> *Causal certainty: reflects the degree of evidence that is known for the threat (High: available evidence strongly links the threat to stresses on population viability; Medium: there is a correlation between the threat and population viability e.g. expert opinion; Low: the threat is assumed or plausible).*

## 4.2 Description of Threats

### ***Conversion of Native Habitat to Industrial Infrastructure***

Badland habitat is susceptible to erosion associated with surface disturbances typical of oil and gas exploration and development (Bradshaw et. al 1995). These include exploration activities (seismic lines, seismic testing), construction (roads, pipelines, facilities, power lines, staging areas), operations (drilling, compressor stations), decommissioning, and reclamation. Oil and gas development is intensive in the Manyberries badlands area of southeast Alberta in proximity to and within Greater Short-horned Lizard habitat.

Within the four areas of occurrence of the Greater Short-horned Lizard in Alberta (Figure 2) there are 2,852 gas or well sites (1,529 active and 1,323 inactive), and within the four areas of occurrence in Saskatchewan (Figure 2) there are 6 gas or oil sites, all inactive (Environment Canada unpubl. data).

Direct loss or degradation of habitat can result from: clearing vegetation for new roads, well pads, pipelines, and production facilities; stripping and mixing of soil; soil compaction from heavy machinery during well drilling and possible localized soil contamination; provision of access into once inaccessible areas; (ERCB 1992; National Energy Board 1996, Cody et al. 2000). In addition, physical disturbances associated with building new infrastructure may alter the availability of certain insect prey (Cody et al. 2000). The impact of crude oil production is greater than that of natural gas production due to the need for all-weather gravel roads and daily transportation.

Greater Short-horned Lizards may be attracted to well pads, perhaps due to slopes associated with the raised bed. Some well pads may act as sink habitat in these situations if mortality arises from vehicle traffic (J. James pers. comm. 2012). Also, above-ground infrastructure associated with wells create perches for avian predators (L. Powell pers. comm. 2012) and attract a variety of mammalian predators and snakes (Anonymous 1949, Tyler 1977, Sherbrooke 1991, James 1997, K. Fink pers. commun. 2012).

Proposed surface mining of ammolite in the range of the Greater Short-horned Lizard in southeast Alberta (COSEWIC 2004) would have the potential to destroy its habitat, and result in mortality of lizards. Replacement of existing substrates with alternative material during reclamation may limit the ability of Greater Short-horned Lizards to burrow into the substrate for overwintering or thermal maintenance (L. Powell pers. comm. 2012). Although such mining has been proposed, no such mines have been developed in Greater Short-horned Lizard habitat to date (J. Nicholson pers. comm. 2013).

### ***Creation of Roads in Native Habitat***

Roads and trails created and used for oil and gas development and operation, and off-road trails created by recreational vehicle use, can disturb and destroy native habitat used by Greater Short-horned Lizards.

### ***Dam and Irrigation Development***

The creation of reservoirs or dams for irrigation may destroy Greater Short-horned Lizard habitat. This could occur during construction of a dam, its inlet channels, the associated structures and access roads, and the use of staging areas for equipment and excavated and stored construction materials. Dam and irrigation development may have caused some minor habitat degradation in a small portion of the Chin Coulee/Forty Mile Coulee region but the species have persisted there, suggesting this habitat damage was not as extensive as initially feared (Powell and Russell 1992, M. Leung pers. comm. 2012).

### ***Conversion of Native Habitat to Crop and Forage Production***

Cultivation of areas used by Greater Short-horned Lizards immediately adjacent to badland habitat results in direct loss of some foraging and dispersal habitat, as lizards may avoid crossing large areas of dense crops (e.g. alfalfa ) or recently cultivated fields with little cover. Conversion of native habitat to cropland has never been a serious threat to Greater Short-horned Lizards in Canada due to soil and terrain limitations for crop and forage production near the majority of lizard habitat.

Conversion of native habitat to Crested Wheatgrass (*Agropyron cristatum*) for cattle forage, can impede movements of Greater Short-horned Lizards along the periphery of their habitat (Powell and Russell 1994).



### ***High-intensity Prolonged Grazing***

Livestock grazing in Greater Short-horned Lizard habitat is thought to have a neutral impact or may even be beneficial by reducing areas of dense vegetation and increasing prey availability and travel lanes for lizards (Newbold and MacMahon 2008). However, in some situations extremely heavy grazing may have an adverse effect on Greater Short-horned Lizards. For example, Greater Short-horned Lizards have been found to occur less frequently in heavily grazed areas than in lightly grazed areas (Jones 1981). Negative impacts of high-intensity prolonged grazing may include: reduction of vegetation structure which may be important for the species thermoregulation and habitat use; high nutrient additions which can greatly increase plant cover and impede Greater Short-horned Lizard movements (L. Powell pers. comm. 2012); and compaction of soil up to 15 cm below the surface (Donkor et al. 2002), which degrades its quality for hibernation (Powell and Russell 1994).

### ***Invasion and Establishment of Exotic Plants***

Invasive plants, such as Downy Brome (*Bromus tectorum*), negatively impact other species of horned lizards by altering the structure and composition of the plant community (Newbold 2005), which may affect prey availability, micro-thermal conditions and the ability of lizards to travel. Under recent, moist conditions, Yellow Sweet-clover (*Melilotus officinalis*) has been increasing in occurrence throughout portions of the Canadian range of Greater Short-horned Lizards, including Grasslands National Park (S. Pruss pers. comm. 2012). Clover can increase soil nitrogen which can facilitate the invasion of other more harmful plants. Road and trail access and traffic associated with oil and gas development and operation can lead to an increase in occurrence of weeds and invasive plant species.

### ***Inclement or Extreme Weather Conditions***

Climate change models predict increases in temperatures in the prairie grasslands but provide little insight into what will happen in terms of climate variability (Barrow 2009). Warmer summers could extend the active period for lizards, and result in enhanced condition of lizards and increased recruitment for local populations. If climate change brings more frequent bouts of extreme cold weather with reduced snow cover, over-winter survival of Greater Short-horned Lizards may be reduced (James 1997). Uncertainty regarding future climatic conditions, particularly any changes in temperature and precipitation among the seasons, results in uncertainty in the potential threat posed by climate change.

***Mortality from Traffic and from Pets due to Urban Expansion***

Traffic associated with roads and trails created and used for oil and gas development and operation, and off-road recreational vehicle use along trails, may cause direct mortality of Greater Short-horned Lizards that use roads and trails as dispersal corridors and of lizards which may be attracted to these more open surfaces as a source of heat when it is cold (L. Powell pers. comm 2012).

In local situations, occasional mortality may arise from urban expansion with its associated traffic and pet activity in proximity to Greater Short-horned Lizard habitat.

***Mortality from Oil Spills***

During oil development and operation there is a risk of mortality of Greater Short-horned Lizards from spills and soil contamination.

***Collection***

Greater Short-horned Lizards are easy to collect and are susceptible to collectors due to their slow-moving behavior. However this may only occur locally and infrequently. It is illegal to collect Greater Short-horned Lizards in Alberta, Saskatchewan and Grasslands National Park.

**5. Population and Distribution Objectives**

Occupancy by Greater Short-horned Lizards has been confirmed for only a small proportion of the apparently suitable habitat. However, attaining reasonably-accurate estimates of population size, at regional and national scales, would require intensive survey work owing to the low detectability of Greater Short-horned Lizards which is a consequence of their small size, cryptic behaviour, and low density in occupied habitats. Due to these uncertainties, population estimates for Alberta and Saskatchewan cannot be used as the basis for the population component of the population and distribution objectives for the species nor for measuring progress towards recovery. However, it is feasible to set a population and distribution objective based on maintaining the existence of extant populations and any populations that are confirmed in the future.

The population and distribution objective for the Greater Short-horned Lizard is to maintain populations in all of the critical habitat polygons within the 8 currently known areas of occupancy of the species plus any new populations discovered in the future. An appropriate measure of the current area of occupancy is the total area of all the polygons of critical habitat (see Section 7.1), calculated to be 132 km<sup>2</sup> in Alberta and Saskatchewan combined, that are within the eight disjunct areas where the species is found (see Figure 2). This calculated area only includes suitable habitat as described in Section 7.1 and is derived from the most recent compilation of valid occurrence information with 94% of the records obtained since 1980. This area can easily be

re-calculated based on new occurrence data, allowing future assessment of persistence or expansion of the area of confirmed occupancy to measure progress towards recovery (Didiuk et al. in prep.).

The species is, and likely has always been, rare and highly localized in Canada which represents the northern fringe of the species' global range. Thus there is no reasonable expectation that the Greater Short-horned Lizard could ever become abundant and common in Canada.

## **6. Broad Strategies and General Approaches to Meet Objectives**

### **6.1 Actions Already Completed or Currently Underway**

Below is a brief summary of actions already completed or underway that will contribute to the recovery of the Greater Short-horned Lizard in Canada.

#### **Monitoring and Assessment**

- Occupancy surveys have been conducted in the known range of the Greater Short-horned Lizard in southeast Alberta (Hornbeck and Green 1990, 1991, Powell and Russell 1991a, 1992, 1998, James 2002, 2003).
- Occupancy surveys have been conducted in Grasslands National Park in southern Saskatchewan (Powell and Russell, 1995, 1998, Powell et al. 1998, K. Fink unpubl. data).

#### **Habitat Assessment, Management, Conservation and Protection**

- A habitat suitability index was developed to prioritize areas for future surveys in southeast Alberta (Taylor 2004).
- Habitat suitability models were developed for the West Block of Grasslands National Park in southern Saskatchewan (K. Fink unpub. data)
- Alberta has placed Protective Notations Under the Public Lands Act for Greater Short-horned Lizard habitat in the Manyberries area. These notations can serve as a tool for conserving habitat for species at risk including the habitat of lizards.
- Nature Conservancy Canada has purchased one property in Alberta where Greater Short-horned Lizards occur and operates the property as a conservation area.
- Portions of Greater Short-horned Lizard habitat where the species occur on OneFour Rangeland Natural Area, Alberta have provisions for avoiding or minimizing impacts of some activities that could degrade or destroy the habitat.

**Research**

- Ecological studies on Greater Short-horned Lizard diet, growth, thermal ecology, reproduction and wintering have been conducted in southeast Alberta (Powell 1982, Powell and Russell 1984, 1985a, 1985b, 1991, 1996, James 1997).
- Movement studies have been conducted for Greater Short-horned Lizard populations in southeast Alberta (Powell and Russell 1993b, 1994, 1996, James 1997) and in southern Saskatchewan (K. Fink unpub. data).
- Current and historical genetic relationships of Greater Short-horned Lizard populations in southeast Alberta have been investigated (M. Leung 2012).

**Communication, Collaboration and Engagement**

- A volunteer monitoring program was developed for Grasslands National Park (2008-2010).

## 6.2 Strategic Direction for Recovery

**Table 2. Recovery Planning Table.** Priorities are defined as: High = top priority action; Medium = needed to evaluate and guide conservation actions; Low = action would be beneficial to the understanding of the species but is not immediately necessary for recovery.

Threat or Limitation	Priority <sup>d</sup>	General Description of Research and Management Approaches
<b>Broad Strategy: Habitat Assessment, Management, Conservation and Protection</b>		
Conversion of Native Habitat to Industrial Infrastructure ; Invasion and Establishment of Exotic Plants; Creation of Roads in Native Habitat; Dams and Irrigation Development; Conversion of native habitat to crop and forage production; High-intensity prolonged grazing	High	<ul style="list-style-type: none"> <li>Development of beneficial management practices and stewardship agreements, focusing on habitat conservation and threat reduction.</li> <li>Assess and report on effective protection of critical habitat on provincial crown and private land.</li> </ul>
<b>Broad Strategy: Monitoring and Assessment</b>		
Measuring progress towards recovery	High	<ul style="list-style-type: none"> <li>Conduct regular surveys of known occupied areas to determine changes in Greater Short-horned Lizard occupancy.</li> </ul>
Knowledge Gaps	High	<ul style="list-style-type: none"> <li>Survey areas of unknown occupancy where habitat appears suitable to increase knowledge of areas of occupancy.</li> </ul>
<b>Broad Strategy: Research</b>		
Conversion of Native Habitat to Industrial Infrastructure ; Invasion and Establishment of Exotic Plants; Creation of Roads in Native Habitat; Dams and Irrigation Development; Conversion of native habitat to crop and forage production; High-intensity prolonged grazing; Inclement or Extreme Weather Conditions	Medium	<ul style="list-style-type: none"> <li>Investigate wintering site requirements to assist in evaluating potential effects of climate change.</li> <li>Examine movement and dispersal patterns for all age classes to identify habitat characteristics required to maintain connectivity among habitat patches</li> </ul>
<b>Broad Strategy: Communication, Collaboration and Engagement</b>		
All threats	Medium	<ul style="list-style-type: none"> <li>Collaborate with multiple jurisdictions in Canada to facilitate delivery of conservation measures and inventory and monitoring activities .</li> <li>Communicate information about Greater Short-horned Lizard management to land managers, oil and gas industry, land owners, visitors to Grasslands National Park, and the general public.</li> </ul>

<sup>d</sup> "Priority" reflects the degree to which the broad strategy contributes directly to the recovery of the species or is an essential precursor to an approach that contributes to the recovery of the species.

### **6.3 Narrative to Support the Recovery Planning Table**

#### ***Habitat Assessment, Management, Conservation and Protection***

Habitat for the Greater Short-horned Lizard in Alberta is located on private lands and provincial crown land, including areas of high- density oil and gas development. Greater Short-horned Lizard conservation is compatible with livestock grazing which is common throughout the range of the species. Stewardship practices which address location of industrial sites and associated vehicular traffic are required.

#### ***Monitoring and Assessment***

Regular, surveys of occupied areas are needed to monitor occupancy trends. Furthermore, additional surveys are necessary in areas that appear to have suitable habitat but where occupancy by Greater Short-horned Lizards has not yet been confirmed.

#### ***Research***

Additional information regarding wintering site selection is necessary to ensure protection of these micro-sites and to evaluate possible effects of climate change on Greater Short-horned Lizards. Developing spatially explicit quantitative habitat models using high resolution imagery will improve knowledge of spatially-explicit habitat requirements. Quantifying movement and dispersal patterns for all age classes is required to identify habitat characteristics necessary to maintain connectivity among habitat patches. Research is needed to assess detectability of Greater Short-horned Lizards in order to improve population estimates derived from surveys of the species.

#### ***Communication, Collaboration and Engagement***

While Greater Short-horned Lizards are difficult to detect, they are easily captured, leaving them particularly susceptible to harassment. Target audiences likely to encounter the animals are oil and gas industry employees working in the species' habitat, landowners, and visitors to Grasslands National Park. Collaboration and communication among jurisdictions will facilitate development and delivery of habitat protection programs and stewardship efforts that aim to reduce harassment as well as inventory and monitoring programs.

## 7. Critical Habitat

### 7.1 Identification of the Species' Critical Habitat

Section 41 (1)(c) of SARA requires that recovery strategies include an identification of the species' critical habitat, to the extent possible, as well as examples of activities that are likely to result in its destruction.

Critical habitat for the Greater Short-horned Lizard is partially identified in this recovery strategy to the extent possible based on the best available information (Didiuk et. al. in prep). It is recognized that the critical habitat identified below is insufficient to achieve the population and distribution objective for the species. The schedule of studies (Table 3) outlines the activities required to identify additional critical habitat necessary to meet the population and distribution objectives of the species. There are a total of 805 reported occurrences of the Greater Short-horned Lizard in Canada, of which 763 occurrences had sufficient information to be used in the identification of critical habitat.

The biophysical attributes of critical habitat for the Greater Short-horned Lizard are:

- badland or coulee terrain dominated by exposed substrates with loose soils suitable for shallow burrowing during the active season and deeper burrowing in winter, and minimal vegetation cover which provides thermal shelter in the active season; and
- upland grassland within 100 m of edges of badland or coulee terrain to provide for local movements of Greater Short-horned Lizards for mate searching during the breeding season, for dispersal of Greater Short-horned Lizards among some patches of badland or coulee terrain, and for some limited foraging.

Critical habitat for the Greater Short-horned Lizard in Canada is identified based upon two approaches, described below. One approach was used at all localities known to be used by the species outside of the West Block of Grasslands National Park, while a habitat model approach was used for within and immediately adjacent to the West Block of Grasslands National Park. The rationale for using two different approaches was that a coupled, habitat-species occurrence model, suitable for the identification of the biophysical attributes of critical habitat, was available for use in identifying suitable habitat in the West Block of Grasslands National Park (K. Fink, unpubl. data). This model had not been developed for the remaining portion of the species Canadian range, necessitating a different, simpler approach in those areas.

Critical habitat identification in and near the West Block of Grasslands National Park used a habitat model that predicted where Greater Short-horned Lizards were likely to occur. Satellite imagery was used to detect suitable habitat features such as exposed

mineral substrate and associated minimal vegetation cover. This information was then coupled with known occurrences of Greater Short-horned Lizards to create a model that predicted where lizards were likely to occur based on habitat characteristics (K.Fink unpubl. data). Suitable habitat that was associated with a moderate or high probability of occurrence of lizards according to the model, and that was within 500 m of known occurrences of the species, was identified as critical habitat. This approach identified three areas of occupancy containing 12 polygons of critical habitat (total 70.4 km<sup>2</sup>) in the West Block of Grasslands National Park, Saskatchewan, associated with 382 occurrences of the Greater Short-horned Lizard (Figure 3).

Critical habitat in and near the East Block of Grasslands National Park, Saskatchewan, and in southeast Alberta was identified based on the presence of the biophysical attributes for critical habitat and confirmed occurrences of the species. A circular polygon of 500 m radius was created for each occurrence to address daily and seasonal habitat requirements. Portions of each polygon not comprised of the biophysical attributes (e.g. grass tablelands more than 100 m from badland habitat) were excluded from the polygon. In some cases proximity of occurrences resulted in overlapping polygons which were consolidated and considered to be a single local area (polygon) of critical habitat. In addition to grass tablelands beyond 100 m from badland habitat, unsuitable habitat such as permanent water bodies, wetlands, woodlands, and anthropogenic features such as buildings, farmyards, structures, high intensity agricultural areas, roads, and park visitor facilities such as parking lots, interpretative sites, recreation trails, day use sites and campgrounds do not possess the attributes required by the Greater Short-horned Lizard and are not identified as critical habitat, even when they occur within the polygons.

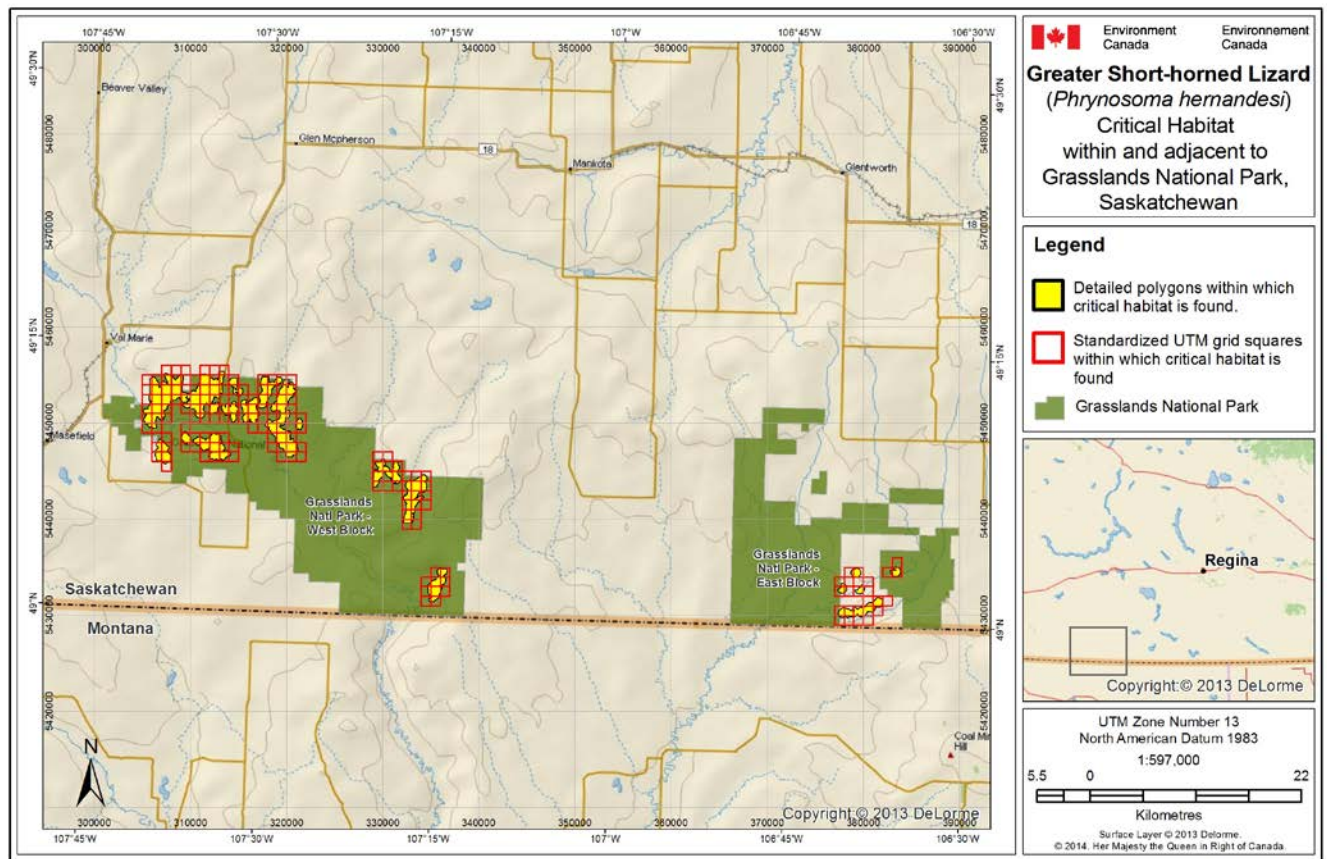
This approach identified, in the one area of occupancy in the East Block of Grasslands National Park, Saskatchewan, five polygons of critical habitat (total 6.6 km<sup>2</sup>) associated with 17 occurrences of the Greater Short-horned Lizard (Figure 3). In the four, disjunct areas of occupancy in southeast Alberta there were 51 polygons of critical habitat identified (total 55.1 km<sup>2</sup>) associated with 364 occurrences of the Greater Short-horned Lizard (Figures 4a, 4b, 4c, 5a and 5b).

The critical habitat polygons for the Greater Short-horned Lizard are presented in Figures 3, 4a, 4b, 5a, 5b and 5c. Critical habitat for the Greater Short-horned Lizard in Canada occurs within the 1km x 1km Universal Transverse Mercator (UTM) grid squares shown on each map, where the criteria and methodology described in this section for identifying critical habitat are met. The 277 quarter-sections within which the critical habitat occurs in southeast Alberta are listed in Appendix B. The 262 quarter-sections within which critical habitat occurs in southwest Saskatchewan are listed in Appendix C.

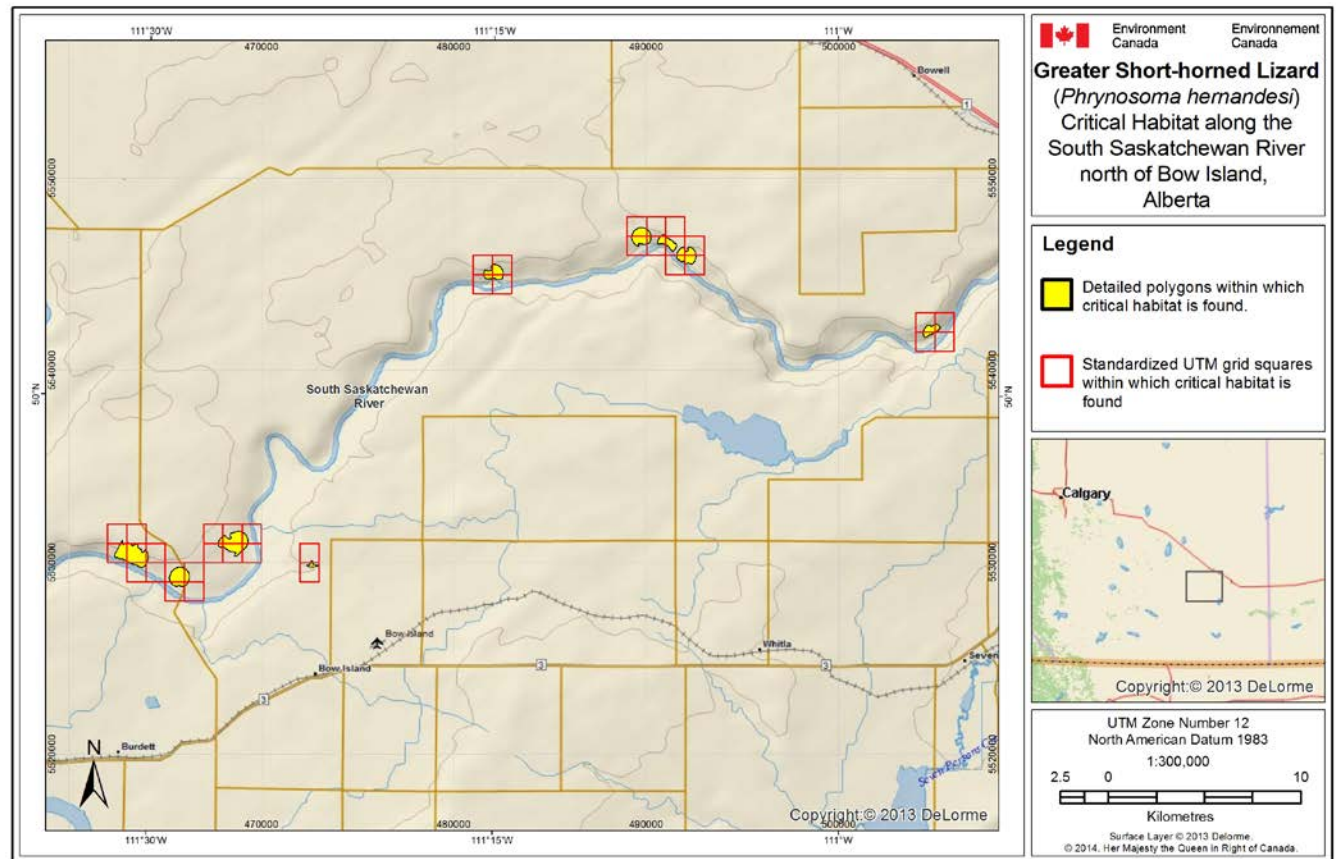
There was insufficient locational information to identify critical habitat for 41 occurrences of the Greater Short-horned Lizard in southeast Alberta (5, 18, 1 and 17 in the vicinity of the Milk River – Lost River, Manyberries, Chin Coulee – Forty Mile Coulee, and South Saskatchewan River Valley areas of occupancy, respectively). In Saskatchewan



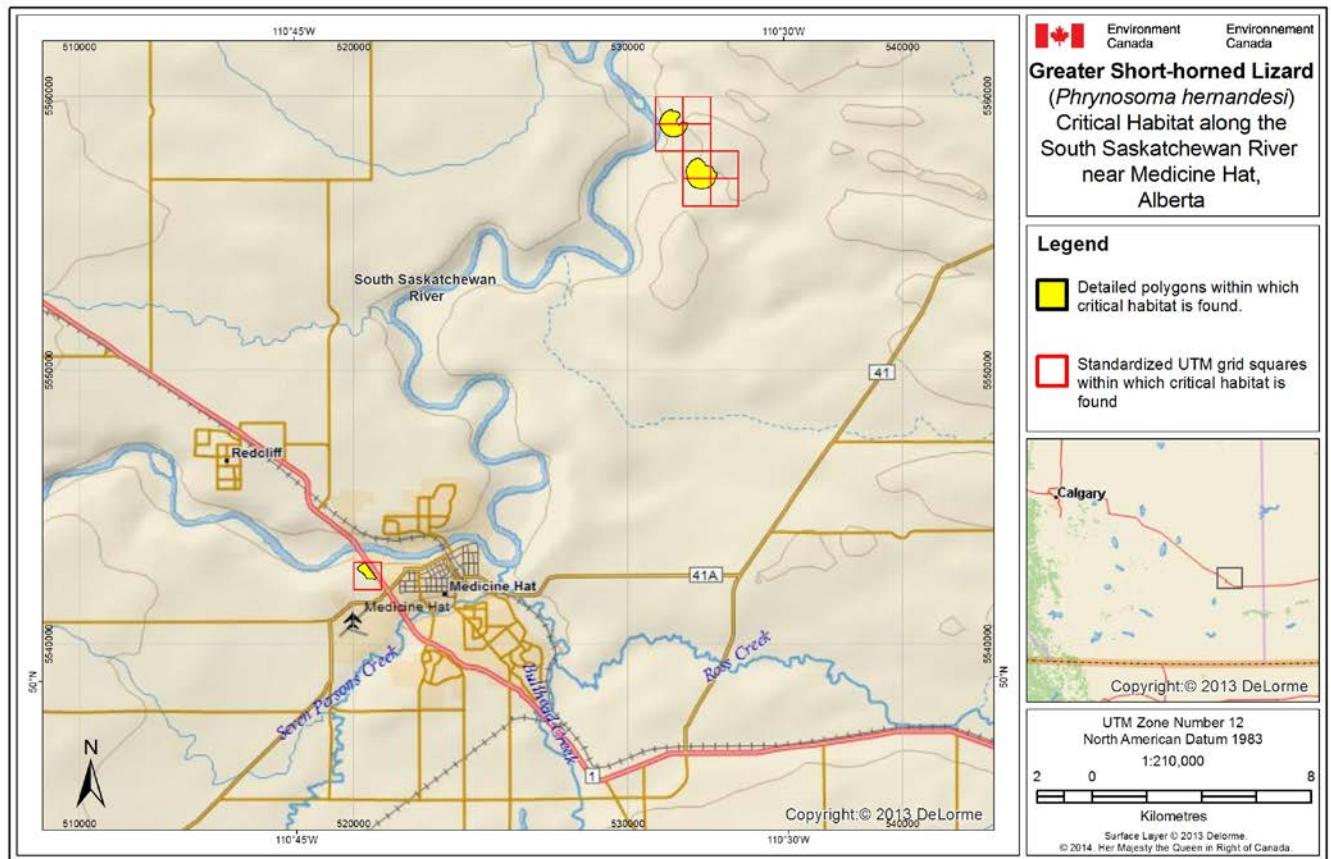
there was one occurrence without sufficient location information in the East Block of Grasslands National Park. Therefore, a schedule of studies, described below, outlines the activities required for identification of additional critical habitat needed to support the population and distribution objectives.



**Figure 3.** Greater Short-horned Lizard critical habitat, within and adjacent to Grasslands National Park, Saskatchewan, occurs within the shaded polygons (yellow) where the criteria and methodology set out in Section 7.1 are met. The 1 km x 1 km UTM grid square overlays (red outline) are part of a standard national grid system that highlights the general geographic area containing critical habitat.

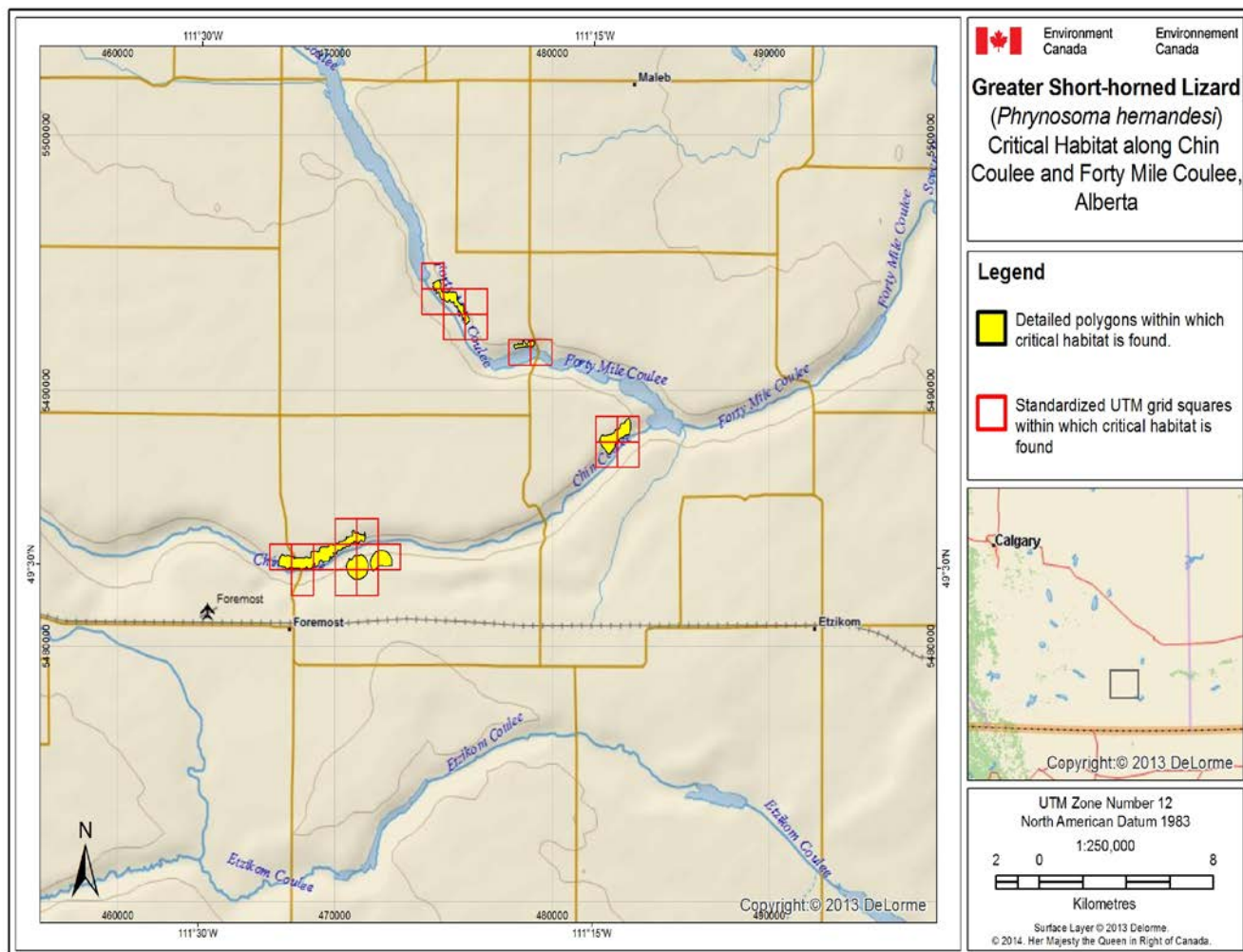


**Figure 4a.** Greater Short-horned Lizard critical habitat, along the South Saskatchewan River north of Bow Island, Alberta, occurs within the shaded polygons (yellow) where the criteria and methodology set out in Section 7.1 are met. The 1 km x 1 km UTM grid square overlays (red outline) are part of a standard national grid system that highlights the general geographic area containing critical habitat.

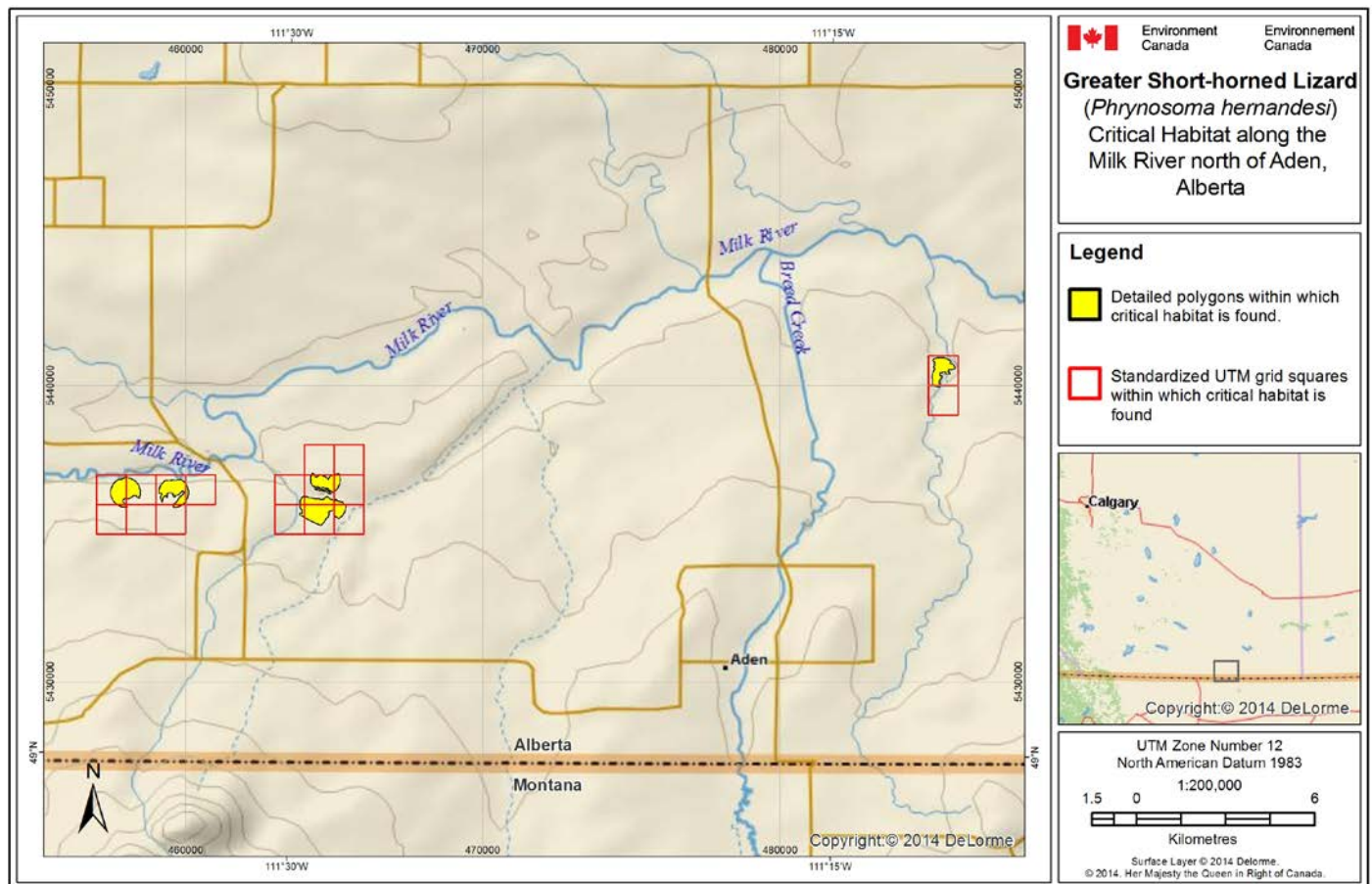


**Figure 4b.** Greater Short-horned Lizard critical habitat, along the South Saskatchewan River near Medicine Hat, Alberta, occurs within the shaded polygons (yellow) where the criteria and methodology set out in Section 7.1 are met. The 1 km x 1 km UTM grid square overlays (red outline) are part of a standard national grid system that highlights the general geographic area containing critical habitat.

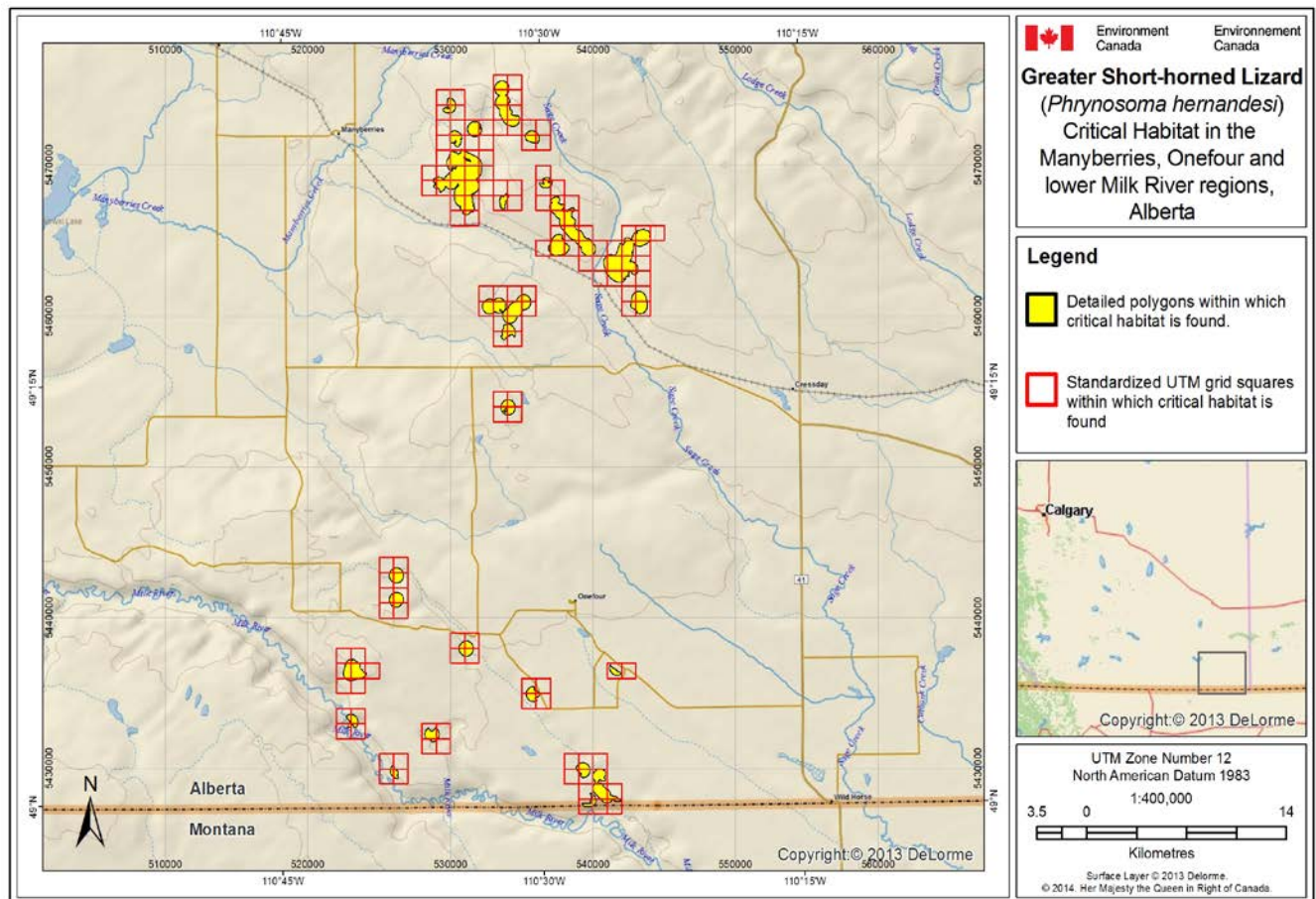




**Figure 5a.** Greater Short-horned Lizard critical habitat along Chin Coulee and Forty Mile Coulee, Alberta, occurs within the shaded polygons (yellow) where the criteria and methodology set out in Section 7.1 are met. The 1 km x 1 km UTM grid square overlays (red outline) are part of a standard national grid system that highlights the general geographic area containing critical habitat.



**Figure 5b.** Greater Short-horned Lizard critical habitat along the Milk River north of Aden, Alberta, occurs within the shaded polygons (yellow) where the criteria and methodology set out in Section 7.1 are met. The 1 km x 1 km UTM grid square overlays (red outline) are part of a standard national grid system that highlights the general geographic area containing critical habitat.



**Figure 5c.** Greater Short-horned Lizard critical habitat in the Manyberries, Onefour and lower Milk River regions, Alberta, occurs within the shaded polygons (yellow) where the criteria and methodology set out in Section 7.1 are met. The 1 km x 1 km UTM grid square overlays (red outline) are part of a standard national grid system that highlights the general geographic area containing critical habitat.

## 7.2 Schedule of Studies to Identify Critical Habitat

Sufficient location information is lacking for 42 reported occurrences of the Greater Short-horned Lizard and these occurrences could not be used in the identification of critical habitat. The following schedule of studies will address these gaps to enable a complete identification of critical habitat for the Greater Short-horned Lizard in Canada.

**Table 3. Schedule of Studies to Identify Critical Habitat**

Description of Activity	Rationale	Timeline
Conduct surveys to confirm existence and location of Greater Short-horned Lizard populations and biophysical attributes of the habitat at or near the 42 reported occurrences without sufficient location information	By using details provided by the original observers (e.g. habitat characteristics, directions) and using the biophysical attributes of suitable Greater Short-horned Lizard's habitat in combination with high resolution imagery, surveying of areas near the reported occurrences may detect and confirm the location of additional populations of Greater Short-horned Lizards.	2015 - 2018

## 7.3 Activities Likely to Result in the Destruction of Critical Habitat

Understanding what constitutes destruction of critical habitat is necessary for the protection and management of critical habitat. Destruction is determined on a case by case basis. Destruction would result if part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single or multiple activities at one point in time, or from the cumulative effects of one or more activities over time (Government of Canada 2009).

Critical habitat for the Greater Short-horned Lizard is destroyed by alteration of soil structure and penetrability such that individuals can no longer use the above or-below ground environment for foraging, locomotion, communication, mating, escaping from predators, burying themselves, taking shelter, acquiring food items, carrying neonates, sunning, shading, or hibernating. Destruction of critical habitat may occur if the ground is excavated, in-filled, stabilized, heavily eroded, if the vegetation community or vegetation structure is altered, or if the thermal environment is modified. It should be noted that some activities may not destroy critical habitat in a single instance, but the combination and cumulative effect of multiple activities, or activities that are repeated over time or that are of long-duration, could have long-term destructive effects on critical habitat.



Examples of activities that are likely to result in destruction of critical habitat include, but are not limited to:

**Compression, covering, inversion, flooding or excavation/extraction of soil.**

Greater Short-horned Lizards often burrow at night and hibernate immediately below the soil surface. Alterations to the soil surface, as described above, may negatively affect their ability to avoid predators, access night-time cover, or overwinter successfully. As low overwinter survival could limit recovery of this species, it is important to avoid activities that negatively influence hibernation. Examples of compression include the creation or expansion of permanent/temporary structures, trails, roads, repeated motorized traffic, and activity that concentrates livestock and alters current patterns of grazing pressure such as spreading bales, building new corrals, adding more salting stations, or adding more water troughs. Examples of covering the soil include the creation or expansion of permanent/temporary structures, spreading of solid waste materials, or roadbed construction. Examples of soil inversion and/or excavation / extraction include new or expanded cultivation, sand and gravel extraction pits, dugouts, road construction, pipeline installation, and stripping of soil for new well pads or fireguards. Flooding from irrigation or dams, which is prolonged or permanent, will eliminate terrestrial habitat for the Greater Short-horned Lizard.

**Removal or alteration of vegetation structure.** Greater Short-horned Lizards rely on sparse vegetation to provide the necessary prey base as well as thermal patchiness necessary for effective thermoregulation. Alteration of vegetation structure by planting or otherwise encouraging the proliferation of non-native plants may destroy critical habitat by impeding movement and dispersal of Greater Short-horned Lizards or by creating excessive shade which hampers effective thermoregulation by Greater Short-horned Lizards. Those activities may also change nutrient availability, encouraging future succession of non-native plant species, which may also influence the prey base. Removal of excessive amounts of vegetation by activities such as the creation of new industrial infrastructure, road development, high-intensity, prolonged grazing and the creation of new dams and irrigation projects may destroy critical habitat by removing essential cover needed for shading and avoidance of predators as well as vegetation needed to support prey species.

## **8. Measuring Progress**

The performance indicator presented below provides a way to define and measure progress toward achieving the population and distribution objectives.

Progress towards meeting the population and distribution objectives must be reported within five years after this recovery strategy is finalized. Success of recovery strategy implementation will be measured against the following indicator:

- Continued persistence of populations in all critical habitat polygons within all 8 areas of known occupancy, and any additionally discovered populations of Greater Short-Horned Lizards in southwest Saskatchewan and southeast Alberta.

## **9. Statement on Action Plans**

One or more action plans for the Greater Short-horned Lizard will be completed by 2018.

## 10. References

Alberta Sustainable Resource Development. 2004. Status of the short-horned lizard (*Phrynosoma hernandesi*) in Alberta: update 2004. Alberta Sustainable Resource Development, Fish and Wildlife Division, and Alberta Conservation Association, Wildlife Status Reptot No. 5 (Update 2004), Edmonton, AB. 27 pp.

Anonymous. 1949. Young rattlesnake chokes to death on horned toad. The Science News-Letter 55(5): 70.

Barrow, E. 2009. Climate Scenarios for Saskatchewan. A Report Prepared for the Prairie Adaptation Research Collaborative (PARC) in co-operation with Saskatchewan Environment. 131 pp.

Barrows, C.S. and M.F. Allen. 2009. Conserving species in fragmented habitats: Population dynamics of the flat-tailed horned lizard, *Phrynosoma mcallii*. The southwest naturalist 54(3):307-316.

Beauchamp, B., B. Wone, S. Bros, and M. Kutilek. 1998. Habitat use of the Flat-tailed Horned Lizard (*Phrynosoma mcalli*) in a disturbed environment. Journal of Herpetology 32(2):210:216.

Blouin, F., B.L. Downey, B.A. Downey, S.L. Frank, D.J. Jarina, P.F. Jones, J.P. Landry-Deboer, and K.S. Rumbolt. 2010. MULTISAR: A Multi-Species Conservation Strategy for Species at Risk 2009-2010 Report. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 135, Edmonton, AB. 71 pp.

Bradshaw, D.A., A. Saxena, D.J. O'Leary, and J.A. Bentz. 1995. Biophysical overview, significant, sensitive and disturbance features of the Manyberries Sensitive Area. GeoWest Environmental Consultants Ltd. Report prepared for Land Information Division, Alberta Environmental Protection, Edmonton, AB. 88 pp.

Cody, W.J., MacInnes, K.L., Cayouette, J., Darbyshire, S. 2000. Alien and invasive native vascular plants along the Normal Wells Pipeline, District of Mackenzie, Northwest Territories. Canadian Field-Naturalist 114:126-137.

Debinski, D.M., and R.D. Holt. 2000. A survey and overview of habitat fragmentation experiments. Conservation Biology 14:342-355.

Didiuk, A., S. Pruss, Knaga, P., J. Conkin, L. Powell, K. Ellingson, M. Leung, J. James, J. Nicholson, B. Bristol and Matthew Weiss in prep. Greater Short-horned Lizard occurrences and critical habitat designation in Alberta and Saskatchewan. CWS Technical Report Series, Canadian Wildlife Service, Saskatoon.

Donkor, N.T., J.V. Gedir, R.J. Hudson, E.W. Bork, D.S. Chansyk, and M.A. Naeth. 2002. Impacts of grazing systems on soil compaction and pasture production in Alberta. *Canadian Journal of Soil Science* 82(1): 1-8.

FWMIS. 2010. Alberta Provincial government database: Fish and Wildlife Management Information System – courtesy Joel Nicholson, Species at Risk Biologist, Edmonton, AB.

Government of Canada. 2009. (draft). *Species at Risk Act* policies overarching policy framework. *Species at Risk Act* Policies and Guidelines Series. Government of Canada.

Hammerson, G.A. 2007. *Phrynosoma hernandesi*. In: IUCN 2010. IUCN Red List of threatened species. Version 2010.4. Available: <http://www.iucnredlist.org> [Accessed March 15, 2011]

IUCN. 2010. IUCN Red List of threatened species. Version 2010.4. Available [www.iucnredlist.org](http://www.iucnredlist.org). (Accessed: March 30, 2011.)

James, J.D. 1997. Pre- and post-parturition thermoregulation in free-ranging female Eastern Short-horned Lizards (*Phrynosoma douglassii brevirostre*) in southern Alberta. M.Sc. Thesis, University of Calgary, Calgary Alberta. 179 pp.

James, J.D. 2002. A survey of Short-horned Lizard (*Phrynosoma hernandesi hernandesi*) populations in Alberta. Alberta Sustainable Resource Development, Fish and Wildlife Division. Alberta Species at Risk Report No. 29. Edmonton AB.

James, J.D. 2003. Short-horned Lizards (*Phrynosoma hernandesi hernandesi*) populations in Alberta – 2002 survey results. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 65. Edmonton, AB 7 pp.

James, J.D., A.P. Russell, and G.L. Powell. 1997. Status of the Eastern Short-horned Lizard (*Phrynosoma douglassii brevirostre*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, Wildlife Status Report No. 5, Edmonton, AB. 20 pp.

Jones, K. B. 1981. Effects of grazing on lizard abundance and diversity in western Arizona. *Southwestern Naturalist*. 26: 107-115.

Leung, M. N. 2012. Phylogeography of the greater short-horned lizard (*Phrynosoma hernandesi*) in Alberta. PhD. thesis, University of Calgary Alberta.

McGuire. 2006. Phylogenetic relationships of horned lizards (*Phrynosoma*) based on nuclear and mitochondrial data: evidence for a misleading mitochondrial gene tree. *Molecular Phylogenetics and Evolution*. 39: 628-644.

Mathies, T. and D.J. Martin. 2008. Overwintering site selection by short-horned lizards (*Phrynosoma hernandesii*) in Northeastern Colorado. *Journal of Herpetology* 42(1) 163-171.

Montanucci, R.R. 1983. Breeding, captive care, and longevity of the short-horned lizard, *Phrynosoma douglassi*. *International Zoo Yearbook*. 23:148-156.

Morris, W.F., and D.F. Doak. 2002. Chapter 2: The causes and quantification of population vulnerability *in* Quantitative Conservation Biology: theory and practice of population viability analysis. xii+480 pp. Sunderland, Massachusetts, USA: Sinauer Associates, Inc.

NatureServe. 2013. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>. (Accessed: October 23, 2013 ).

Newbold, T.A.S. and J.A. MacMahon. 2008. Consequences of cattle introduction in a shrubsteppe ecosystem: indirect effects on desert horned lizards (*Phrynosoma platyrhinos*). *Western North American Naturalist* 68(3): 291-302.

Newbold, T.A.S. 2005. Desert horned lizard (*Phrynosoma platyrhinos*) locomotor performance: The influence of cheatgrass (*Bromus tectorum*). *The Southwest Naturalist* 50(1) 17-23.

NOM-059-ECOL-2001, NORMA Oficial Mexicana, Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. 85 pp.

Pearce, J.L., D.T. McKinnon, and D.A. Kirk. 2010. Analysis of threats to species-at-risk on the South of the Divide Project Area. Report to the Saskatchewan Ministry of the Environment. 102 pp.

Pianka, E.R. 1966. Convexity, desert lizards and spatial heterogeneity. *Ecology* 47:1055-1059

Powell, G.L. 1982. The Eastern Short-horned Lizard. In Alberta: basic field ecology of northern marginal populations. M.Sc. thesis. University of Calgary, Calgary, Alberta, Canada. 343 pp.

Powell, G.L. and A.P. Russell. 1984. The diet of the Eastern Short-horned Lizard, *Phrynosoma douglassi brevirostre* in Alberta and its relationship to sexual size dimorphism. *Canadian Journal of Zoology* 62:428-440.

Powell, G.L. and A.P. Russell. 1985a. Growth and sexual size dimorphism in Alberta populations of the Eastern Short-horned Lizard, *Phrynosoma douglassi brevirostre*. *Canada Journal of Zoology* 63:139-154.

Powell, G.L. and A.P. Russell. 1985b. Field thermal ecology of the Eastern Short-horned Lizard (*Phrynosoma douglassii brevirostre*) in southeastern Alberta. Canadian Journal of Zoology 63:228-238.

Powell, G.L. and A.P. Russell. 1991a. Distribution of the Eastern Short-horned Lizard (*Phrynosoma douglassii brevirostre*) in Alberta. Canada. Northwestern Naturalist 72:21-26.

Powell, G.L. and A.P. Russell. 1991 b. Paturition and clutch characteristics of short-horned lizards (*Phrynosoma douglassii brevirostre*) from Alberta. Canada Journal of Zoology 69:2759-2764.

Powell, G.L. and A.P. Russell. 1992. A preliminary survey of the distribution and abundance of the Eastern Short-horned Lizard (*Phrynosoma douglasii brevirostre*) in Alberta. Unpublished report to the Recreation, Parks and Wildlife Foundation, Edmonton, AB. 135 pp.

Powell, G.L. and A.P. Russell. 1993b. A radiotelemetric study of movement and thermal ecology in an Alberta population of the Eastern Short-horned Lizard (*Phrynosoma douglassii brevirostre*), Unpublished report to Alberta Fish and Wildlife Division, Lethbridge, AB. 74 pp.

Powell, G.L. and A.P. Russell. 1994. A radio telemetric study of movement, thermal ecology and hibernation site selection in an Albertan population of the Eastern Short-horned Lizard (*Phrynosoma douglassii brevirostre*). Unpublished report to Alberta Environmental Protection, Fish and Wildlife Division, Lethbridge, AB. 132 pp.

Powell, G.L. and A.P. Russell. 1995. Short-horned Lizards (*Phrynosoma douglassii brevirostre*) in Grasslands National Park. A report on the 1995 field season. Unpublished report to Grasslands National Park, Val Marie, SK, 48pp.

Powell, G.L. and A.P. Russell. 1996. Movement, thermal ecology, seasonal activity and overwinter behaviour in an Alberta population of the Easter Short-horned Lizard (*Phrynosoma douglasii brevirostre*): the 1994 study. Unpublished report to Alberta Environmental Protection, Fish and Wildlife Division, Lethbridge, AB. 128 pp.

Powell, G.L. and A.P. Russell. 1998. The status of short-horned lizards, *Phrynosoma douglasi* and *P. hernandesi*, in Canada. The Canadian Field-Naturalist 112(1):1-16.

Powell, G.L., A.P. Russell, and P.J. Fargey. 1998. The distribution of the Short-horned Lizard *Phrynosoma hernandesi* in Saskatchewan, Canada. Northwestern Naturalist 79:19-26.

Sherbrooke, W.C. 1981. Horned Lizards, unique reptiles of western North America, Southwest Parks and Monuments Association, Earl Jackson, editor, 48 pp.

Sherbrooke, W.C. 1991. Behavioral (predator-prey) interaction of captive grasshopper mice (*Onychomys torridus*) and horned lizards (*Phrynosoma cornutum* and *P. modestum*). The American Midland Naturalist 126(1):187-195.

Sherbrooke, W. C. 2003. Introduction to horned lizards of North America. University of California Press, Berkeley, CA. 178 pp.

Stebbins, R.C. 2003. A field guide to western reptiles and amphibians. Third Edition. Houghton Mifflin Co., Boston, MA. 533pp.

Taylor, B.N. 2004. Short-horned Lizard (*Phrynosoma hernandesi hernandesi*), pp 124-130 in Downey B.A., B.L. Downey, R.W. Quinlan, O. Castelli, V.J. Remesz and P.F. Jones (eds.). 2004. MULTISAR: The Milk River Basin Habitat Suitability Models for Selected Wildlife Management Species. Alberta Sustainable Resource Management, Fish and Wildlife Division, Alberta Species at Risk Report No. 86, Edmonton, AB.

Tyler, J.D. 1977. Coachwhip preys on horned lizard. The Southwestern Naturalist 22(1): 146.

Zamudio, K.R. 1998. The evolution of female-based sexual size dimorphism: A population-level comparative study in horned lizards (*Phrynosoma*). Evolution 52(6): 1821-1833.

Zamudio, K.R., K. B. Jones, and R.H.Ward. 1997. Molecular systematic of short-horned lizards: biogeography and taxonomy of a widespread species complex. Systematic Biology 46(2): 284-305.

### **Personal Communications**

Acorn, J. 2011. Faculty Service Officer, Department of Renewable Resources, University of Alberta, Edmonton, Alberta.

Ells, S. 2009. Environmental Consultant, Richardson Environmental, Athabasca, Alberta.

Sissons, R. 2010. Conservation Biologist, Grasslands National Park, Parks Canada Agency, Val Marie, Saskatchewan.

## APPENDIX A: Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the [\*Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals\*](#)<sup>4</sup>. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the [\*Federal Sustainable Development Strategy\*](#)'s (FSDS)<sup>5</sup> goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

Recovery approaches outlined in this strategy focus on protecting the species' natural habitat, increasing knowledge of the species and maintaining the existing distribution of the species. Negative effects on the environment and other species are not anticipated. It is expected that most other species occurring in the same areas as the Greater Short-horned Lizard will benefit from this strategy, via increased knowledge gained through inventory, monitoring and research programs, and on-the-ground conservation and recovery initiatives. Other species expected to benefit from this strategy include: Mormon Metalmark butterfly (*Apodemia mormo*), Prairie Rattlesnake (*Crotalus viridis*), Prairie Garter Snake (*Thamnophis radix*), Bullsnae (*Pituophis catenifer*), and Plains Hognose Snakes (*Heterodon nasicus nasicus*), plus other species that may utilize lizards as a food source, such as Prairie Loggerhead Shrikes (*Lanius ludovicianus excubitorides*). Implementation of recovery actions for Greater Short-horned Lizards in Saskatchewan and Alberta will be integrated with those for other species at risk wherever possible, for example, through the South of the Divide Multi-species Action Plan in southwest Saskatchewan, the Grasslands National Park Action Plan, and through the MULTISAR program in Alberta.

This recovery strategy directly contributes to the goals and targets of the *Federal Sustainability Development Strategy for Canada*. Specifically, it contributes to Goal 5: "Wildlife Conservation – Maintain or restore populations of wildlife to healthy levels", and to Goal 6: "Ecosystem/Habitat Conservation and Protection- Maintain productive and resilient ecosystems with the capacity to recover and adapt".

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<sup>4</sup> <http://www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1>

<sup>5</sup> [www.ec.gc.ca/dd-sd/default.asp?lang=En&n=F93CD795-1](http://www.ec.gc.ca/dd-sd/default.asp?lang=En&n=F93CD795-1)



## **APPENDIX B: Legal Land Description of Quarter Sections that Contain Critical Habitat (see Biophysical Attributes Described in Section 7.1) for Greater Short-Horned Lizard in Southeast Alberta**

<b>Quarter</b>	<b>Section</b>	<b>Township</b>	<b>Range</b>	<b>Meridian</b>
SW	1	1	4	4
NE	2	1	4	4
NW	2	1	4	4
SE	2	1	4	4
SW	2	1	4	4
NE	3	1	4	4
SE	3	1	4	4
SW	3	1	4	4
NE	10	1	4	4
NW	10	1	4	4
SE	10	1	4	4
SW	10	1	4	4
NW	11	1	4	4
SW	11	1	4	4
NE	29	1	4	4
NW	29	1	4	4
SE	29	1	4	4
SW	29	1	4	4
NE	35	1	4	4
SE	35	1	4	4
NW	36	1	4	4
SW	36	1	4	4
NE	8	1	5	4
NW	8	1	5	4
SE	8	1	5	4
SW	8	1	5	4
NW	15	1	5	4
NE	16	1	5	4
SE	21	1	5	4
SW	22	1	5	4
NW	31	1	5	4
SW	31	1	5	4
NE	24	1	6	4
NW	24	1	6	4
SE	24	1	6	4
SW	24	1	6	4
NE	36	1	6	4
NW	36	1	6	4
SE	36	1	6	4
SW	36	1	6	4
SW	31	1	11	4
NE	25	1	12	4

NW	25	1	12	4
NE	32	1	12	4
NW	32	1	12	4
SE	32	1	12	4
SW	32	1	12	4
NE	33	1	12	4
SE	33	1	12	4
NW	33	1	12	4
SW	33	1	12	4
NE	36	1	12	4
NW	36	1	12	4
SE	36	1	12	4
SW	36	1	12	4
NE	2	2	5	4
NW	2	2	5	4
SE	2	2	5	4
SW	2	2	5	4
NE	17	2	5	4
NW	17	2	5	4
SE	17	2	5	4
SW	17	2	5	4
NE	20	2	5	4
NW	20	2	5	4
SE	20	2	5	4
SW	20	2	5	4
SE	1	2	6	4
SW	1	2	6	4
NW	7	2	9	4
SE	18	2	9	4
SW	18	2	9	4
NE	30	3	4	4
NW	30	3	4	4
SE	30	3	4	4
SW	30	3	4	4
NE	18	4	3	4
NW	18	4	3	4
SE	18	4	3	4
SW	18	4	3	4
NW	19	4	3	4
SW	19	4	3	4
NW	30	4	3	4
SW	30	4	3	4
NE	31	4	3	4
NW	31	4	3	4
SE	31	4	3	4
SW	31	4	3	4
NE	7	4	4	4
NW	7	4	4	4
SE	7	4	4	4
SW	7	4	4	4

NE	13	4	4	4
SE	13	4	4	4
NE	17	4	4	4
NW	17	4	4	4
SW	17	4	4	4
NE	18	4	4	4
NW	18	4	4	4
SE	18	4	4	4
SW	18	4	4	4
NE	23	4	4	4
NE	24	4	4	4
NW	24	4	4	4
SE	24	4	4	4
SW	24	4	4	4
NE	25	4	4	4
NW	25	4	4	4
SE	25	4	4	4
SW	25	4	4	4
NE	26	4	4	4
NW	26	4	4	4
SE	26	4	4	4
NE	27	4	4	4
NW	27	4	4	4
NE	28	4	4	4
NW	28	4	4	4
NE	33	4	4	4
SE	33	4	4	4
SW	33	4	4	4
NE	34	4	4	4
NW	34	4	4	4
SE	34	4	4	4
SW	34	4	4	4
SW	35	4	4	4
SE	36	4	4	4
SW	36	4	4	4
NE	13	4	5	4
NW	13	4	5	4
SE	13	4	5	4
SW	13	4	5	4
NW	3	5	4	4
SW	3	5	4	4
NE	4	5	4	4
NW	4	5	4	4
SE	4	5	4	4
SW	4	5	4	4
NE	6	5	4	4
NW	6	5	4	4
SW	6	5	4	4
SE	7	5	4	4
SW	7	5	4	4

NE	8	5	4	4
SE	8	5	4	4
NW	9	5	4	4
SW	9	5	4	4
NE	19	5	4	4
NW	19	5	4	4
NE	20	5	4	4
NW	20	5	4	4
SE	20	5	4	4
SW	20	5	4	4
SW	29	5	4	4
NE	30	5	4	4
NW	30	5	4	4
SE	30	5	4	4
SW	30	5	4	4
NE	31	5	4	4
NW	31	5	4	4
SE	31	5	4	4
SW	31	5	4	4
NW	1	5	5	4
SW	1	5	5	4
NE	2	5	5	4
NW	2	5	5	4
SE	2	5	5	4
NE	10	5	5	4
NW	10	5	5	4
SE	10	5	5	4
SW	10	5	5	4
NE	11	5	5	4
NW	11	5	5	4
SE	11	5	5	4
SW	11	5	5	4
NW	12	5	5	4
SW	12	5	5	4
NW	13	5	5	4
SW	13	5	5	4
NE	14	5	5	4
NW	14	5	5	4
SE	14	5	5	4
SW	14	5	5	4
NE	15	5	5	4
SE	15	5	5	4
NE	23	5	5	4
NW	23	5	5	4
SE	23	5	5	4
SW	23	5	5	4
NW	24	5	5	4
SW	24	5	5	4
SW	25	5	5	4
NW	26	5	5	4

SE	26	5	5	4
SW	26	5	5	4
NE	27	5	5	4
SE	27	5	5	4
SW	35	5	5	4
NE	26	6	11	4
NW	26	6	11	4
SE	26	6	11	4
SW	26	6	11	4
NE	27	6	11	4
NW	27	6	11	4
SE	27	6	11	4
NE	28	6	11	4
NW	28	6	11	4
SE	28	6	11	4
SW	28	6	11	4
NE	29	6	11	4
SE	29	6	11	4
SE	34	6	11	4
SW	34	6	11	4
SW	35	6	11	4
NE	12	7	10	4
NW	12	7	10	4
SE	12	7	10	4
SW	12	7	10	4
NE	21	7	10	4
NW	22	7	10	4
NW	29	7	10	4
SW	29	7	10	4
NE	30	7	10	4
NW	30	7	10	4
SE	31	7	10	4
SW	31	7	10	4
NE	17	11	11	4
NW	17	11	11	4
NE	18	11	11	4
NW	19	11	11	4
SW	19	11	11	4
SE	20	11	11	4
SW	20	11	11	4
NE	21	11	11	4
NW	21	11	11	4
NW	22	11	11	4
SE	24	11	11	4
SW	24	11	11	4
SW	27	11	11	4
SE	28	11	11	4
NE	24	11	12	4
NW	24	11	12	4
SE	24	11	12	4

SW	24	11	12	4
SW	25	11	12	4
NE	26	12	6	4
SE	35	12	6	4
SW	36	12	6	4
NW	29	12	7	4
NE	30	12	7	4
SW	32	12	7	4
NE	1	13	9	4
NW	1	13	9	4
NE	10	13	9	4
NE	11	13	9	4
NW	11	13	9	4
SE	11	13	9	4
NE	12	13	9	4
NW	12	13	9	4
SE	12	13	9	4
SW	12	13	9	4
SW	14	13	9	4
SE	15	13	9	4
NE	1	13	10	4
NW	1	13	10	4
SE	1	13	10	4
SW	1	13	10	4
NE	2	13	10	4
SE	2	13	10	4
NE	7	14	4	4
NW	7	14	4	4
SE	18	14	4	4
SW	18	14	4	4
SW	19	14	4	4
NE	13	14	5	4
NE	24	14	5	4
SE	24	14	5	4
SW	24	14	5	4

## **APPENDIX C: Legal Land Description of Quarter Sections that Contain Critical Habitat (see Biophysical Attributes Described in Section 7.1) for Greater Short-Horned Lizard in Southwest Saskatchewan**

Quarter	Section	Township	Range	Meridian
NE	5	1	5	3
NW	5	1	5	3
NE	6	1	5	3
NW	6	1	5	3
SE	7	1	5	3
SW	7	1	5	3
NE	8	1	5	3
SE	8	1	5	3
SW	8	1	5	3
NE	9	1	5	3
NW	9	1	5	3
SE	9	1	5	3
SW	9	1	5	3
NE	17	1	5	3
NW	17	1	5	3
SE	17	1	5	3
SW	17	1	5	3
NW	18	1	5	3
SE	18	1	5	3
SW	18	1	5	3
NE	19	1	5	3
SE	19	1	5	3
NW	20	1	5	3
SW	20	1	5	3
NE	22	1	5	3
NW	22	1	5	3
SE	22	1	5	3
SW	22	1	5	3
NE	1	1	6	3
SE	12	1	6	3
NE	13	1	6	3
SE	13	1	6	3
NW	2	1	10	3
NE	3	1	10	3
NE	10	1	10	3
SE	10	1	10	3
NE	11	1	10	3
NW	11	1	10	3
SW	11	1	10	3
NE	14	1	10	3
NW	14	1	10	3
SE	14	1	10	3

SW	14	1	10	3
SE	15	1	10	3
SE	23	1	10	3
SW	23	1	10	3
NE	32	1	10	3
NE	33	1	10	3
NW	33	1	10	3
NE	4	2	10	3
NW	4	2	10	3
SE	4	2	10	3
SW	4	2	10	3
SE	5	2	10	3
NE	8	2	10	3
SE	8	2	10	3
NE	9	2	10	3
NW	9	2	10	3
SE	9	2	10	3
SW	9	2	10	3
NW	10	2	10	3
SW	10	2	10	3
NW	15	2	10	3
SW	15	2	10	3
NE	16	2	10	3
NW	16	2	10	3
SE	16	2	10	3
SW	16	2	10	3
NE	17	2	10	3
NW	17	2	10	3
SE	17	2	10	3
SW	17	2	10	3
NE	18	2	10	3
NW	18	2	10	3
SW	18	2	10	3
NE	19	2	10	3
NW	19	2	10	3
SE	19	2	10	3
SW	19	2	10	3
NE	20	2	10	3
NW	20	2	10	3
SE	20	2	10	3
SW	20	2	10	3
SW	22	2	10	3
SE	30	2	10	3
SW	30	2	10	3
NE	13	2	11	3
SE	13	2	11	3
NE	19	2	11	3
NW	19	2	11	3
SE	24	2	11	3
NW	29	2	11	3



SW	29	2	11	3
NE	30	2	11	3
NW	30	2	11	3
SE	30	2	11	3
SW	30	2	11	3
NE	31	2	11	3
NW	31	2	11	3
SE	31	2	11	3
SW	31	2	11	3
NW	32	2	11	3
NE	20	2	12	3
NW	20	2	12	3
NE	21	2	12	3
NW	21	2	12	3
NE	25	2	12	3
SE	25	2	12	3
NW	28	2	12	3
SE	28	2	12	3
SW	28	2	12	3
NE	29	2	12	3
NW	29	2	12	3
SE	29	2	12	3
SW	29	2	12	3
NE	30	2	12	3
NW	30	2	12	3
SE	30	2	12	3
SE	31	2	12	3
SW	31	2	12	3
SE	32	2	12	3
SW	32	2	12	3
SW	33	2	12	3
NE	35	2	12	3
NE	36	2	12	3
NW	36	2	12	3
SE	36	2	12	3
SW	36	2	12	3
NE	22	2	13	3
NE	23	2	13	3
NW	23	2	13	3
SE	23	2	13	3
SW	23	2	13	3
NE	25	2	13	3
NE	26	2	13	3
NW	26	2	13	3
SE	26	2	13	3
SW	26	2	13	3
NE	27	2	13	3
SE	27	2	13	3
NE	34	2	13	3
NW	34	2	13	3

SE	34	2	13	3
SE	36	2	13	3
SE	5	3	11	3
SW	5	3	11	3
NE	6	3	11	3
NW	6	3	11	3
SE	6	3	11	3
SW	6	3	11	3
NE	7	3	11	3
NW	7	3	11	3
SE	7	3	11	3
SW	7	3	11	3
NW	8	3	11	3
NW	17	3	11	3
SW	17	3	11	3
NE	18	3	11	3
NW	18	3	11	3
SE	18	3	11	3
SW	18	3	11	3
SW	19	3	11	3
NE	1	3	12	3
NW	1	3	12	3
SE	1	3	12	3
SW	1	3	12	3
NE	2	3	12	3
NW	2	3	12	3
SE	2	3	12	3
SW	2	3	12	3
NE	3	3	12	3
NW	3	3	12	3
SE	3	3	12	3
SW	3	3	12	3
NE	4	3	12	3
NW	4	3	12	3
NE	5	3	12	3
NW	5	3	12	3
SE	5	3	12	3
SW	5	3	12	3
NE	6	3	12	3
NW	6	3	12	3
SE	6	3	12	3
NE	7	3	12	3
NW	7	3	12	3
SE	7	3	12	3
SW	7	3	12	3
NE	8	3	12	3
NW	8	3	12	3
SE	8	3	12	3
SW	8	3	12	3
NE	9	3	12	3

NW	9	3	12	3
SE	9	3	12	3
SW	9	3	12	3
NE	10	3	12	3
NW	10	3	12	3
SE	10	3	12	3
SW	10	3	12	3
NE	11	3	12	3
NW	11	3	12	3
SE	11	3	12	3
SW	11	3	12	3
NE	12	3	12	3
NW	12	3	12	3
SE	12	3	12	3
SW	12	3	12	3
NE	13	3	12	3
NW	13	3	12	3
SE	13	3	12	3
SW	13	3	12	3
NE	15	3	12	3
NW	15	3	12	3
SE	15	3	12	3
SW	15	3	12	3
NE	16	3	12	3
NW	16	3	12	3
SE	16	3	12	3
SW	16	3	12	3
NE	17	3	12	3
NW	17	3	12	3
SE	17	3	12	3
SW	17	3	12	3
NW	18	3	12	3
SE	18	3	12	3
SW	18	3	12	3
SE	20	3	12	3
SW	20	3	12	3
SE	21	3	12	3
SW	21	3	12	3
SE	24	3	12	3
SW	24	3	12	3
NW	1	3	13	3
NE	2	3	13	3
NW	2	3	13	3
SE	2	3	13	3
SW	2	3	13	3
NE	3	3	13	3
SE	3	3	13	3
NE	10	3	13	3
SE	10	3	13	3
NE	11	3	13	3

NW	11	3	13	3
SE	11	3	13	3
SW	11	3	13	3
NE	12	3	13	3
NW	12	3	13	3
SE	12	3	13	3
SW	12	3	13	3
NE	13	3	13	3
NW	13	3	13	3
SE	13	3	13	3
SW	13	3	13	3
NE	14	3	13	3
NW	14	3	13	3
SE	14	3	13	3
SW	14	3	13	3
NE	15	3	13	3
SE	15	3	13	3
SE	23	3	13	3
SE	24	3	13	3
SW	24	3	13	3