Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Buffalograss (*Buchloë dactyloides*) in Canada

Buffalograss

2007

Environment Canada Environnement Canada

Canada

About the *Species at Risk Act* Recovery Strategy Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003, and one of its purposes is *"to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity."*

What is recovery?

In the context of species at risk conservation, **recovery** is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of the species' persistence in the wild. A species will be considered **recovered** when its long-term persistence in the wild has been secured.

What is a recovery strategy?

A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species. It sets goals and objectives and identifies the main areas of activities to be undertaken. Detailed planning is done at the action plan stage.

Recovery strategy development is a commitment of all provinces and territories and of three federal agencies — Environment Canada, Parks Canada Agency, and Fisheries and Oceans Canada — under the Accord for the Protection of Species at Risk. Sections 37–46 of SARA (www.sararegistry.gc.ca/the_act/default_e.cfm) outline both the required content and the process for developing recovery strategies published in this series.

Depending on the status of the species and when it was assessed, a recovery strategy has to be developed within one to two years after the species is added to the List of Wildlife Species at Risk. Three to four years is allowed for those species that were automatically listed when SARA came into force.

What's next?

In most cases, one or more action plans will be developed to define and guide implementation of the recovery strategy. Nevertheless, directions set in the recovery strategy are sufficient to begin involving communities, land users, and conservationists in recovery implementation. Cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

The series

This series presents the recovery strategies prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as strategies are updated.

To learn more

To learn more about the *Species at Risk Act* and recovery initiatives, please consult the SARA Public Registry (www.sararegistry.gc.ca/) and the Web site of the Recovery Secretariat (www.speciesatrisk.gc.ca/recovery/).

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2007

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Additional copies:

Additional copies can be downloaded from the SARA Public Registry (www.sararegistry.gc.ca/).

Cover illustration: Buffalograss by Candace Neufeld ©

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DECLARATION

This recovery strategy has been prepared in cooperation with the jurisdictions responsible for the buffalograss. Environment Canada has reviewed and accepts this document as its recovery strategy for the buffalograss, as required under the *Species at Risk Act*. This recovery strategy also constitutes advice to other jurisdictions and organizations that may be involved in recovering the species.

The goals, objectives and recovery approaches identified in the strategy are based on the best existing knowledge and are subject to modifications resulting from new findings and revised objectives.

This recovery strategy will be the basis for one or more action plans that will provide details on specific recovery measures to be taken to support conservation and recovery of the species. The Minister of the Environment will report on progress within five years.

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 or any other jurisdiction alone. In the spirit of the Accord for the Protection of Species at Risk, the Minister of the Environment invites all responsible jurisdictions and Canadians to join Environment Canada in supporting and implementing this strategy for the benefit of the buffalograss and Canadian society as a whole.

RESPONSIBLE JURISDICTIONS

Environment Canada
Government of Manitoba
Government of Saskatchewan

AUTHORS

This strategy was prepared by Candace Neufeld and Darcy Henderson (Canadian Wildlife Service, Environment Canada).

ACKNOWLEDGMENTS

The recovery strategy was prepared by Candace Neufeld and Darcy Henderson, in consultation with the Recovery Team for Plants at Risk in the Prairie Provinces. The Recovery Team for Plants at Risk in the Prairie Provinces provided valuable comments on the drafts of this document. Recovery team members, as of November 2006, include Darcy Henderson (Chair, Environment Canada), Candace Neufeld (Secretary, Environment Canada), Jason Greenall (Manitoba Conservation), Robin Gutsell (Alberta Sustainable Resource Development), Sue McAdam (Saskatchewan Environment), Chris Nykoluk (Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration), and Peggy Strankman (Canadian Cattlemen's Association). Recovery team participants, as of November, 2006, include Delaney Boyd

(Department of National Defence, CFB-Suffield), Joel Nicholson (Alberta Sustainable Resource Development), Sherry Lynn Punak (Department of National Defence, CFB-Shilo), Cheryl Ann Beckles (Department of National Defence, CFB-Dundurn). Dean Nernberg (Environment Canada) was the recovery team chair until August 2005. Helpful comments were also provided by R. Décarie, D. Duncan C. Foster, R. Franken, and Jocelyne Lavallée. The Saskatchewan Conservation Data Centre and the Manitoba Conservation Data Centre provided updated element occurrences for this species. Special thanks to C. Foster, Manitoba Conservation Data Centre, who spent countless hours providing us with current data from Manitoba. The authors would also like to thank all the landowners, lessees and land managers who granted access to their land to surveys. The cover illustration was provided by the co-author, Candace Neufeld.

STRATEGIC ENVIRONMENTAL ASSESSMENT

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*. 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.

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 on non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below.

This recovery strategy will clearly benefit the environment by promoting the recovery of the buffalograss. The potential for the strategy to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this strategy will clearly benefit the environment and will not entail any significant adverse effects. The reader should refer to the following sections of the document in particular: Needs of Buffalograss; Threats; Recovery Objectives; Approaches Recommended to Meet Recovery Objectives and Effects on Other Species.

RESIDENCE

SARA defines residence as: *a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating* **[Subsection 2(1)]**.

Residence descriptions, or the rationale for why the residence concept does not apply to a given species, are posted on the SARA public registry: www.sararegistry.gc.ca/plans/residence_e.cfm.

PREFACE

The *Species at Risk Act* (SARA, Section 37) requires the competent minister to prepare recovery strategies for listed extirpated, endangered or threatened species. Buffalograss was listed as threatened under SARA in June 2003. The Canadian Wildlife Service – Prairie and Northern Region, Environment Canada led the development of this recovery strategy. All responsible jurisdictions reviewed and approved the strategy. The strategy meets SARA requirements in terms of content and process (Sections 39-41). It was developed in cooperation or consultation with:

1) provincial jurisdictions in which the species occurs – Saskatchewan and Manitoba
2) industry stakeholders – Canadian Cattlemen's Association

This will be the first recovery strategy for buffalograss posted on the Public Registry.

EXECUTIVE SUMMARY

- Buffalograss is a perennial grass, reproducing asexually by aboveground stolons and sexually by male and female flowers which occur on separate plants. Seeds from the female plant are contained within protective, globular burs. In Canada, it is associated with the Souris River valley and tributaries in southwestern Manitoba and southeastern Saskatchewan. Currently, there are five populations in Manitoba and one in Saskatchewan, with a minimum estimated area of occupancy of 407 ha and 1.27 ha, respectively.

- Currently identified threats to buffalograss are: habitat loss and degradation from strip coal mining, flooding from reservoirs/dams, cultivation, construction or upgrading of roads, urban expansion, clay pit mining; invasive exotic species; changes in ecological dynamics or natural processes due to a lack of grazing and/or fire regimes.

- The long-term recovery goal is to maintain the persistence of all naturally occurring populations in Canada. Because of difficulties in counting individuals or clones of buffalograss, population objectives have not been set, and distribution objectives are based on two scales involving area of occupancy and number of occupied quarter-sections. Due to incomplete data these should be viewed as short-term objectives (5 years):
    1) Saskatchewan - Estevan population: Maintain at least 1.27 hectares in at least 17 quarter-sections.
    2) Manitoba - Souris River population: Maintain at least 402 hectares in approximately 43 quarter-sections.
    3) Manitoba - Sourisford Park population: Maintain at least 0.01 hectares (136 m^2) in at least 1 quarter-section.
    4) Manitoba - Blind River Valley North (Element occurrence number 6): Maintain at least 4.2 hectares in at least 2 quarter-sections.
    5) Manitoba - Blind River Valley South (Element Occurrence Number 5): Maintain at least 0.79 hectares (7974 m^2) in at least 1-2 quarter-sections.
    6) Manitoba - Blind River Valley East (Element Occurrence Number 11): Maintain at least 0.01 hectares (137 m^2) in at least 1 quarter-section.

- Four objectives have been identified for the recovery of buffalograss:
    1) Objective 1: Develop and promote beneficial management practices and stewardship agreements to land owners, land managers, stakeholders and industry to reduce threats to buffalograss and its habitat by 2012 (Priority – Urgent).
    2) Objective 2: Identify critical habitat by 2011 (Priority – Urgent).
    3) Objective 3: Identify extent of occurrence and area of occupancy of buffalograss populations, to the extent possible, by 2012 (Priority - Necessary).
    4) Objective 4: Monitor trends in area of occupancy for existing populations through 2017 (Priority - Beneficial).

- Research and management activities needed to achieve these objectives include: developing, communicating and implementing beneficial management practices to reduce threats; establishing stewardship agreements with affected land owners/land managers to protect habitat; creating set-back distance guidelines for disturbances; researching habitat

associations; conducting research required for population viability analysis, and completing critical habitat identification; researching impact of threats and management practices; establishing standardized monitoring and inventory guidelines, and; continuing with monitoring and inventorying activities.

- The identification of critical habitat will occur, following additional survey effort, in one or more action plans, developed in cooperation with the responsible jurisdictions.

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1. BACKGROUND

1.1 Species Assessment Information from COSEWIC

Date of Assessment: November 2001

Common Name: Buffalograss

Scientific Name: *Buchloë dactyloides*

COSEWIC Status: Threatened

Reason for Designation: A perennial clonal grass with male and female unisexual plants, with very restricted occurrences in two small areas of Saskatchewan and Manitoba and disjunction from the core range of the species to the south.

Canadian Occurrence: SK, MB

COSEWIC Status History: Designated Special Concern in April 1998. Status re-examined and designated Threatened in November 2001. Last assessment based on an existing status report.

1.2 Description

Buffalograss (*Buchloë dactyloides* [Nutt.] Engelm.) is a member of the grass family (Poaceae). This perennial, late-developing (C4) shortgrass is unusual because it reproduces asexually by stolons[1], and sexually by male and female flowers which almost always occur on separate plants (dioecious) (Quinn and Engel 1986, Huff and Wu 1992). Vegetative dispersal occurs along stolons (Figure 1), which root at the nodes, resulting in clonal patches as large as 3 m or more in diameter. Under ideal conditions, stolons can grow as much as 5.72 cm per day (Mueller 1941, Quinn 1991, Harms in press). Buffalograss can also reproduce vegetatively by rhizomes, but at a slower rate (Mueller 1941). Leaves are grayish-green and curly, about 2-10 cm long and 1-2 mm wide, with

Figure 1. A buffalograss stolon.

[1] Stolons are elongated, horizontal above-ground stems that creep along the ground, rooting at nodes or tips resulting in new plants (Harrington 1977, Harris and Harris 2001). Rhizomes are elongated, horizontal underground stems which root at the nodes, producing new plants (Harrington 1977, Harris and Harris 2001).

fine hairs on the upper and lower surfaces, including a fringe of hair where the leaf meets the stem. Flowering times vary among plants (Quinn 1991), but in Canada most flowering is complete by mid-July with ripened seed shattering by late July or early August (Harms in press, C. Neufeld, pers. obs.).

Buffalograss has separate male and female plants (Figure 2), with only an occasional report of monoecious plants containing both female and male parts (Quinn and Engel 1986, Shaw *et al.* 1987, Huff and Wu 1992). Male plants have 2 or 3 spikes, about 5 to 15 mm long, at the end of stalks up to 20 cm tall (Figure 2). Each spike is made up of spikelets, each of which contains two pollen-bearing grass flowers between papery bracts. Spikelets are arranged in two rows on one side of the spike. Pollen is wind dispersed, although dispersal distance is limited because the pollen is released close to the ground (Jones and Newell 1946, Beetle 1950, Quinn 1998). Male spikes superficially resemble flowering spikes of blue grama (*Bouteloua gracilis*), and because both species occur in the same habitat buffalograss is often overlooked. Tight clusters of two or three female flowers are hidden among the leaves, and enclosed in a bur-like structure on a short stalk (Figure 2). Upon maturing, these structures harden into globular, toothed burs containing 1-5 seeds (Figure 3; Looman and Best 1979, Boivin 1981, Quinn and Engel 1986, Harms in press). At least 50% of burs contain seeds producing both male and female plants (Quinn and Engel 1986, Quinn 1987). Burs become the dispersal units and remain intact to protect seeds from fire or heat damage, desiccation, or animal consumption. Burs also aid in dispersal, anchor seedlings to the ground, enhance seed longevity and inhibit germination until sufficient moisture is available (Ahring and Todd 1977, Quinn 1987). Dispersal of the bur by wind is limited because of its weight and location lower down in the foliage; thus, seeds tend to end up clumped in the soil near parent plants (Coffin and Lauenroth 1989, Quinn 1998). Long distance dispersal of burs is achieved through ingestion and passage through the intestinal tract of grazers (e.g., cattle or bison), and to a lesser extent by attachment to animal fur, mud on animal hooves, or in runoff water after a storm (Quinn 1987, Quinn 1991, Quinn *et al.* 1994, Quinn 1998). Buffalograss seeds, even within a single bur, have varying germination and dormancy periods, which may allow multiple chances to colonize a single microsite under varying climatic and competitive conditions (Quinn 1987).

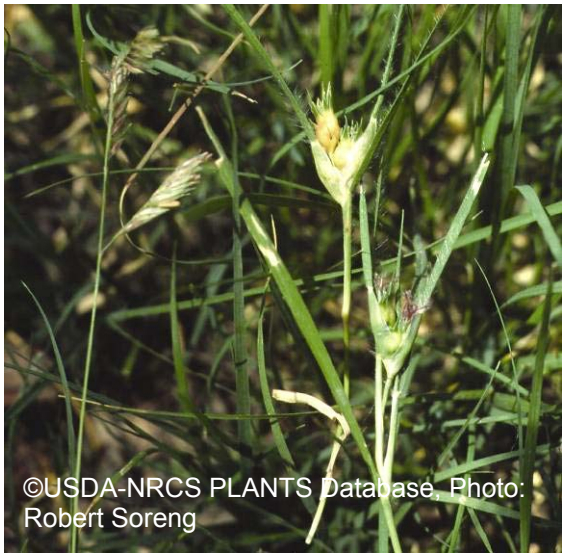

Figure 2. Male buffalograss plant (left) and female buffalograss plant (right).

Figure 3. Burs from female buffalograss plant.

1.3 Populations and Distribution

Buffalograss is native to North America, ranging from the Chihuahuan desert of central Mexico, through the west interior basin, and south-central and west-central semi-arid prairies of the United States, to the temperate semi-arid prairies of Canada (Figure 4; Commission for Environmental Cooperation 1997). In Canada, buffalograss is only found along the Souris River and its tributaries in south-east Saskatchewan, and south-west Manitoba. In both provinces, buffalograss is ranked as S1, or critically imperiled. Similarly, its national ranking in Canada is also critically imperiled, or N1 (NatureServe 2006). In 2001, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) reassessed buffalograss as threatened instead of special concern based on an existing status report (COSEWIC in press). In the United States, buffalograss has a national status of N4N5, or demonstrably widespread, abundant and apparently secure (NatureServe 2006). Within its core in the United States, a status ranking has not been assigned for most of the states including Texas, Colorado, New Mexico, Oklahoma, Kansas, Nebraska, South Dakota, North Dakota, and Montana (NatureServe 2006). Disjunct or peripheral populations occur in Arkansas, Louisiana, Wisconsin, Georgia and Nevada where the status is not ranked. Peripheral populations of buffalograss in Arizona, Missouri, Iowa, and Utah have a status of critically imperiled (S1), and in Illinois buffalograss is imperiled (S2). An introduced population occurs in Virginia (NatureServe 2006). Globally, buffalograss is ranked as G4G5, or secure (NatureServe 2006).

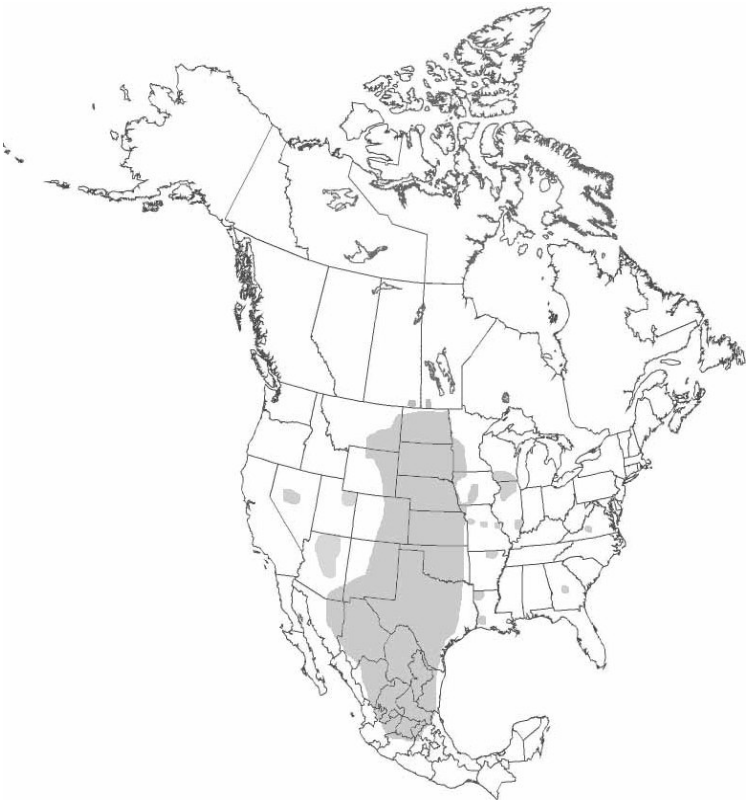

Figure 4. Known range of buffalograss in North America (modified from Harms in press, USDA 2006).

Buffalograss is a common grass species in much of the core of its range in the United States. It is likely that only one percent or less of the species' global distribution and abundance is found in Canada (Figure 4). According to the United States Department of Agriculture (USDA) Natural Resources Conservation Service's plant database (USDA 2006), the nearest locations in the United States are likely in North Dakota in the counties of Ward, Pierce and Walsh. Exact information on locations of buffalograss within these counties is not available; however, these sites are over 50-100 kilometers from locations in Manitoba and Saskatchewan.

1.3.1 Canada

In Canada, buffalograss is very restricted to localized areas of Manitoba and Saskatchewan (Figure 5). In Manitoba, 5 populations[2] have been identified to date along a 17 km length of the Souris River valley, and an 8 km length of the Blind River valley (Foster and Hamel 2006, Manitoba Conservation Data Centre, unpubl. data). At the time the COSEWIC status report was prepared, Buffalograss was only known from 6 quarter-sections and was estimated to occupy 1.01 hectares in Manitoba (Harms in press). Subsequent search efforts have been more intensive, and as of 2006 Buffalograss is known to have an area of occupancy[3] greater than 407 hectares distributed over 49 quarter-sections (Manitoba Conservation Data Centre, unpubl. data). Area of occupancy has not been measured for all known locations of buffalograss; only presence data has been collected for large portions of some populations. For example, mixed grass prairie surveys around the Souris River have found buffalograss present in 1,992 hectares; this value represents the total area surveyed rather than the specific areas where buffalograss is located, and may be considered the potential area of occupancy. Future surveying and mapping efforts will likely increase the known area of occupancy, and potentially the extent of occurrence (C. Foster, pers. comm.); currently disjunct populations may be amalgamated into fewer and larger populations.

In Saskatchewan, one population has been identified along the Souris River valley southwest to west of Estevan (Figure 5). At the time the COSEWIC status report was prepared, Buffalograss was only known from 10 quarter-sections and was estimated to occupy 0.02 hectares (234.5 m^2) in Saskatchewan (Harms in press). Following surveys completed in 2005 and 2006, Buffalograss is known to have an area of occupancy at least 1.27 ha distributed across at least 17 quarter-sections (C. Neufeld, unpubl. data). However, as with Manitoba, area of occupancy has not been measured for all known locations of Buffalograss; only presence data has been collected for some quarter-sections. Future surveying and mapping efforts will likely increase the known area of occupancy, and additional populations may be discovered in native grasslands south and east of Estevan.

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[2] Using the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) definition, populations are defined as geographically or otherwise distinct groups within a species that have little demographic or genetic exchange (typically one successful breeding immigrant individual or gamete per generation or less) (COSEWIC 2006). This is equivalent to the term "subpopulation" employed by the World Conservation Union (IUCN 2001). NatureServe considers sites within 1 km of each other, or within 2 km if there is appropriate habitat between the sites, to be from the same element occurrence (population) (NatureServe 2006). It should be noted that with genetic research, it may be found that genetic exchange occurs at distances further or less than 1 km, and therefore, our definition of a population may change; this may result in splitting or lumping of sites which will change the number of populations, but this itself should not be interpreted as an increasing or decreasing trend. The Canadian population, or total population, is the total number of mature individuals in Canada (equivalent to the term "population" employed by the World Conservation Union) (COSEWIC 2006).

[3] As buffalograss is a clonal species, and often forms dense mats or turf when clones merge with neighbouring clones, it is impossible to count individual plants and difficult to accurately count clones. Therefore, its area of occupancy, or the size of the patches it forms, are often recorded and used as a way to monitor buffalograss. Area of occupancy as defined by COSEWIC is "the area within 'extent of occurrence' that is occupied by a taxon, excluding cases of vagrancy" (COSEWIC 2006). Extent of occurrence as defined by COSEWIC is "the area included in a polygon without concave angles that encompasses the geographic distribution of all known populations of a species" (COSEWIC 2006).

Although it is likely that some buffalograss sites have been lost, there is insufficient historical and long-term data collected for this species, and a lack of standardized methodology, to determine a trend for area of occupancy.

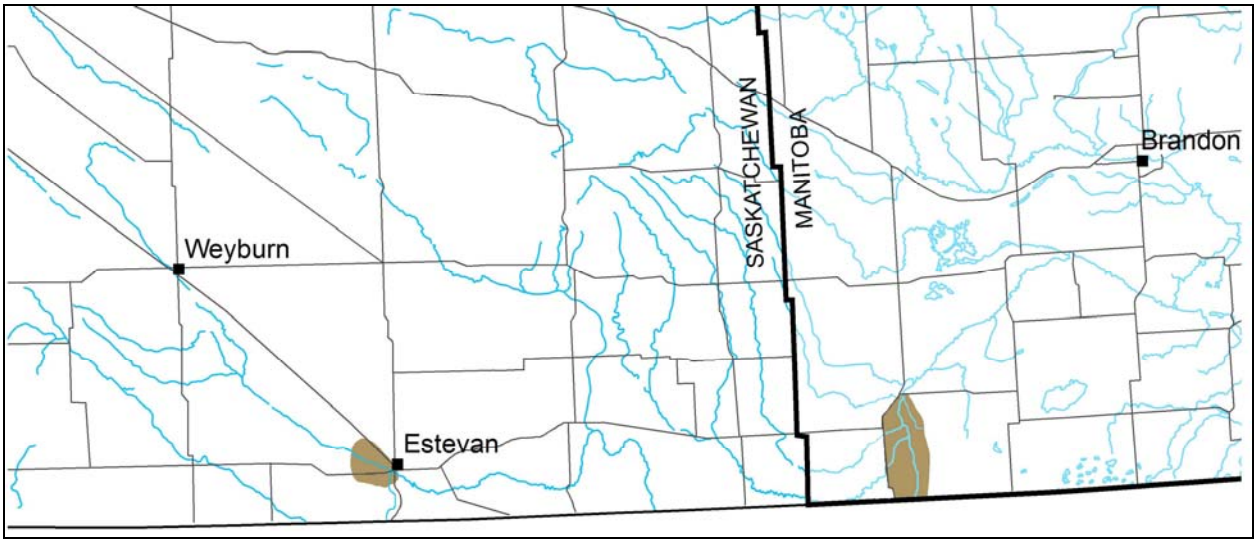

Figure 5. Known range of buffalograss in Canada.

1.4 Needs of Buffalograss

1.4.1 Habitat and biological needs

Buffalograss occurs in the Moist Mixed Prairie Ecoregion of Saskatchewan and in the Aspen Parkland Ecoregion of Manitoba, within the Prairie Ecozone (Wiken 1986, Ecological Stratification Working Group 1995; for more detail on physiography see Harms in press). This area is dominated by a steppe climate (northern cool-temperate zone) characterized as having occasional water deficits resulting from low precipitation, high evaporation, and rapid surface run-off (Harms in press, Fung *et al.* 1999). There is a strong seasonal pattern in both precipitation and temperature. Mean annual precipitation ranges from 433 mm in Saskatchewan to 467 mm in Manitoba; most falls in summer with a peak in June and winters are relatively dry. Summers are warm with a mean July temperature of 19.5 ° C, while winters are cold with a mean January temperature ranges from -14.8 ° C in Saskatchewan to -15.5 ° C in Manitoba (Environment Canada 2006).

Buffalograss is co-dominant with blue grama over much of the shortgrass and mixed-grass prairie of the United States, and is also common there in numerous other ecosystems (e.g., semidesert grasslands, coastal prairie, tallgrass prairie, pinyon-juniper, ponderosa pine woodland). On a microsite level, buffalograss occurs mostly on clay soils with a relatively higher moisture and phosphorus availability (Schimel *et. al.* 1985, Bai 1989, Richard and Redente 1995), and is more prevalent on lower slope positions relative to upland summits (Richard and Redente 1995, Reimer *et al.* 2003, C. Neufeld, pers. obs.). In Canada, Buffalograss is at its northernmost extent and appears restricted to specific habitat along the Souris River valley and tributary coulees in Saskatchewan and Manitoba, including the Blind River valley in Manitoba.

Buffalograss inhabits dry, shallow coulee bottoms, lower coulee slopes, mid-slope benches, and adjacent upland in slight depressions or adjacent to soil disturbances like cattle trails (Harms in press, Reimer *et al.* 2003, C. Neufeld, pers. obs.). Soil parent materials include glacial fluvial meltwater channels with marine sedimentary rock exposures, as well as more recent eroded and colluvial slopes, alluvial fans and channels surrounded by glacial moraine and lacustrine deposits. The varying stages of soil development result in a range of soil suborders from orthic dark-brown and black chernozems, solods and solonetzic to rego chernozems, orthic and cumulic regosols (Eilers *et al.* 1978, Manitoba Land Resource Unit 1997, Saskatchewan Soil Survey 1997). One apparently consistent soil characteristic where Buffalograss occurs is clay to loam texture (Eilers *et al.* 1978, Harms in press, Saskatchewan Soil Survey 1997, Reimer *et al.* 2003, C. Foster, pers. comm.).

Buffalograss typically inhabits areas disturbed by grazing and dominated by blue grama (*Bouteloua gracilis*), needle-and-thread grass (*Stipa comata*) and western wheatgrass (*Agropyron {Pascopyrum} smithii*) (Harms in press, Reimer *et al.* 2003). As buffalograss typically forms dense circular clones which exclude most other species, it is often the dominant plant where it grows, comprising up to 80-90% of the ground cover (Reimer *et al.* 2003, C. Neufeld unpubl. data). Other commonly associated vegetation includes Kentucky bluegrass (Poa pratensis), June grass (*Koeleria macrantha*), gumweed (*Grindelia squarrosa*), pasture sage (*Artemisia frigida*), prairie sage (*Artemisia ludoviciana*), royal pennyweed (*Hedeoma hispida*), foxtail barley (*Hordeum jubatum*), yellow flax (*Linum rigidum*), prairie coneflower (*Ratibida columnifera*), yarrow (*Achillea millefolium*), sweet clover (*Melilotus* spp.), broomweed (*Gutierrezia sarothrae*) inland salt grass (*Distichlis stricta*), little club moss (*Selaginella dens*a), tumblegrass (*Schedonnardus paniculatus*), prairie bird's-foot trefoil (*Lotus purshianus*), fragile pricklypear (*Opuntia fragilis*) and pincushion cactus (*Coryphantha vivipara*) (Harms in press, Reimer *et al.* 2003, Manitoba Conservation Data Centre, unpubl. data, C. Neufeld, unpubl. data).

1.4.2 Ecological role

Buffalograss is an important forage grass for livestock grazing in the United States, due to its resilience to grazing, tolerance to semi-arid and drought conditions, and its palatability with high protein and nutrient content year-round (Dittberner and Olson 1983, Howard 1995). It is also important forage for a variety of wildlife, including elk (*Cervus elaphus*), deer (*Odocoileus* spp.), and pronghorn antelope (*Antilocapra americana*). Buffalograss is increasingly becoming important in the United States as a turfgrass for golf courses and landscaping projects, including ditches, airport runways, athletic fields, and recreational areas because of its low maintenance, sod-forming nature, short stature, drought tolerance, trampling tolerance, and good competitive abilities (Pozarnsky 1983, Quinn 1998, Mintenko *et al.* 2002); cultivars have been developed which are easier to establish from seed rather than from plugs or sod (Mintenko *et al.* 2002). Buffalograss is also being used in revegetation projects to decrease erosion and rehabilitate surface-mined lands, bentonite/ coal-mine spoil piles, and drilling fluid burial sites (Vogel 1981, Thornburg 1982, Sieg *et al.* 1983, McFarland *et al*. 1994). In the United States, studies have found buffalograss to be an important recolonizer of cultivated fields and old roads 5-10 years after abandonment because of its ability to rapidly spread vegetatively (Judd 1974, Coffin *et al.* 1996). This recolonization reduces wind and water erosion, and returns these areas back to

native species. These abandoned fields can become dominated by buffalograss and blue grama 25-50 years after abandonment (Coffin *et al.* 1996).

Historically, buffalograss served numerous functions. Buffalograss sod was used by settlers to build sod houses in the west-central Great Plains, and likely was used for grazing cattle and horses (Lowe 1940, Harms in press). Acoma and Laguna tribes in the southern United States crushed buffalograss stolons with yucca root or soaked it in water for use as a dermatological aid to make hair grow (Swank 1932). The Blackfoot tribe used buffalograss as forage for horses during fall and winter (Johnston 1987).

1.4.3 Limiting factors

All plants require sunlight, heat, moisture, nutrients and space for establishment, growth, and reproduction. As a warm-season (C4) perennial grass at the extreme northern edge of its range, buffalograss is probably limited primarily by growing season length. C4 perennial grasses transplanted further north often develop slowly and fail to complete reproduction (Potvin 1986, Linhart and Grant 1996). Also, populations at the limits of a species' range often are more fragmented and less dense, and they occupy poorer habitat than populations at the core of the species' range (Vucetich and Waite 2003, Channell and Lomolino 2000). This may make them more susceptible to fragmentation effects, such as lower immigration rates and higher extinction rates. Habitat differences at the limits of its range may also affect a species persistence; as a short-statured perennial grass adapted to dry and relatively nutrient-poor ecosystems with a similarly low vegetation structure, habitats supporting taller plants that would otherwise form a canopy and limit sunlight availability would likely limit buffalograss.

The seed-containing burs of buffalograss are adapted to dispersal by animals. Small hairs on the awns of the burs aid in attachment to fur, and slow passage of the bur through the rumen, allowing greater dispersal distances. Retention time of burs within cattle digestive tracts is between 1-5 days during which cattle can move a substantial distance (Quinn and Hervey 1970, Quinn *et al.* 1994, Ortmann *et al.* 1998). Ingestion of burs, and their subsequent deposition on the ground in dung, results in higher germination rates than undigested burs (Quinn *et al.* 1994, Ortmann *et al.* 1998). The dung substrate initially kills or suppresses existing ground cover thereby reducing competition, and provides moisture and nutrients to the seedling (Quinn *et al.* 1994). In the absence of these grazing animals, or restriction of their movement by fenced areas, there may be an accumulation of seeds under the parent plants leading to a lack of germination, seedling death or eventual inbreeding depression (Quinn 1987, Coffin and Lauenroth 1989, Quinn 1991, Quinn *et al.* 1994). With a lack of reproductive dispersal, vegetative growth by stolons would be the main method of increasing distribution.

1.5 Protection

Buffalograss is protected under the Canadian *Species at Risk Act* (SARA) where it occurs on federal lands. It was recently declared as threatened under the Manitoba *Endangered Species Act*, but as of 2007, it was not listed under provincial legislation in Saskatchewan, although a small Buffalograss Provincial Ecological Reserve has been established in Saskatchewan where buffalograss is protected by the Ecological Reserves Act. Conditions at this site are not optimal

for buffalograss and require some management; however, grazing is not allowed under the current management plan. In Saskatchewan, buffalograss also occurs on private and leased provincial crown land. In Manitoba, buffalograss occurs primarily on private land, with one location within a park owned by a rural municipality.

1.6 Threats

The major threats to buffalograss relate to habitat loss and degradation, and invasion by exotic species. Because buffalograss has a small area of occupancy where it is localized into clumped patches or narrow bands, destruction to even small areas of existing sites would greatly decrease the known population in Canada. Threats are discussed in more detail below, with a categorization of the threats in Table 1.

1.6.1 Threat classification

Table 1. Threat Classification Table

1	**Coal strip mining**	**Threat Information**		
Threat Category	Habitat loss and degradation	**Extent**	Localized	
			Local	**Range-wide**
General Threat	Coal strip (open-pit) mining	**Occurrence**	Current/ Anticipated	
		Frequency	One-time	
Specific Threats	Habitat conversion, habitat fragmentation, removal of substrate/plants/seed bed, introduction of invasive exotic species	**Causal Certainty**	High	
		Severity	Unknown (High)	
Stress	Mortality of plants and seeds, reduced population size	**Level of Concern**	High	
2	**Invasive Exotic Species**	**Threat Information**		
Threat Category	Exotic species	**Extent**	Widespread[a]	
			Local	**Range-wide**
General Threat	Invasive exotic species	**Occurrence**	Current	Anticipated
		Frequency	Continuous	
Specific Threat	Resource and plant competition, alteration of habitat characteristics (e.g., litter, vegetation height and composition), changes in species community	**Causal Certainty**	Unknown	
		Severity	High	Moderate
Stress	Reduced population size, increased seed dormancy, increased plant mortality, reduced germination	**Level of Concern**	High	

Table 1 (continued). Threat Classification Table

3	Lack of grazing and/or alteration to fire regime	Threat Information		
Threat Category	Changes in ecological dynamics or natural processes	**Extent**	Local (Grazing)/Range-wide (Fire)	
			Local	**Range-wide**
General Threat	Lack of, grazing and/or alteration to fire regimes	**Occurrence**	Current	Current
		Frequency	Continuous	Continuous (?)
Specific Threat	Plant competition, alteration of habitat characteristics (e.g. litter, bare ground, vegetation height), changes in species community	**Causal Certainty**	Medium	Medium
		Severity	Low-Moderate	High
Stress	Reduced population size/viability, increased mortality, increased seed dormancy, reduced seed germination	**Level of Concern**	Medium	

4	Flooding by Reservoirs and Dams	Threat Information		
Threat Category	Changes in ecological dynamics or natural processes/ Habitat loss or degradation	**Extent**	Local	
			Local	**Range-wide**
General Threat	Flooding by small catchment dams and dugouts in valleys and coulees; Flooding by existing large-scale dams/reservoirs.	**Occurrence**	Historic/Current / Anticipated	
		Frequency	Seasonal	
Specific Threat	Reduced microhabitat, alteration of habitat characteristics, possible change in species community	**Causal Certainty**	Medium	
		Severity	Medium	
Stress	Reduced population size, increased mortality	**Level of Concern**	Medium	

5	Cultivation	Threat Information		
Threat Category	Habitat loss and degradation	**Extent**	Range-wide	
			Local	**Range-wide**
General Threat	Cultivation, crop production, conversion to tame forages	**Occurrence**	Mostly Historic/ Unknown	
		Frequency	One-time/Recurrent	
Specific Threat	Habitat conversion, fragmentation, isolation, disturbance/removal of substrate and/or seed bed	**Causal Certainty**	High	
		Severity	High	
Stress	Mortality of plants and seeds, reduced population size, local extinctions, reduced genetic exchange	**Level of Concern**	Medium	

Table 1 (continued). Threat Classification Table

6	Road Construction or Upgrades	Threat Information		
Threat Category	Habitat loss or degradation	**Extent**	Local	
			Local	**Range-wide**
General Threat	Construction or upgrading of roads	**Occurrence**	Historic/ Anticipated	
		Frequency	One-time/ recurrent	
Specific Threat	Habitat fragmentation, isolation, habitat conversion, direct mortality, exotic species invasion	**Causal Certainty**	High	
		Severity	Low	
Stress	Reduced population size, increased mortality, reduced genetic exchange	**Level of Concern**	Low-Medium	
7	**Urban expansion**	**Threat Information**		
Threat Category	Habitat loss or degradation	**Extent**	Localized	
			Local	**Range-wide**
General Threat	Urban expansion/ acreage or housing development	**Occurrence**	Anticipated	
		Frequency	One-time	
Specific Threat	Habitat conversion, fragmentation, isolation, disturbance/removal of substrate and/or seed bed	**Causal Certainty**	High	
		Severity	Low	
Stress	Mortality of plants and seeds, reduced population size, local extinctions	**Level of Concern**	Low-Medium	
8	**Clay pit mining**	**Threat Information**		
Threat Category	Habitat loss and degradation	**Extent**	Localized	
			Local	**Range-wide**
General Threat	Clay pit mining	**Occurrence**	Historic/ Anticipated	
		Frequency	One-time	
Specific Threat	Habitat conversion, removal of substrate/ plants/ seed bed, introduction of invasive exotic species	**Causal Certainty**	High	
		Severity	Low	
Stress	Mortality of plants and seeds, reduced population size	**Level of Concern**	Low	

[a] The presence of particular invasive exotic species, and their extent or degree of threat differs between occurrences.

1.6.2 Description of threats

Coal strip (open pit) mining

Lignite coal occurs in horizontal beds within the Ravenscrag Formation, which extends over the Estevan area. Coal is surface mined from large open pits about 35 m deep, created by draglines removing topsoil, subsoil, and overlying rock covering the coal seams. There are four actively producing coal mines in the Estevan area (Saskatchewan Industry and Resources 2006), some of which are operating immediately adjacent to existing buffalograss sites (Harms in press, C. Neufeld, pers. obs.). Expansion of strip mining in the direction of existing sites would destroy large portions of the Saskatchewan population. It is unknown whether any sites have already been impacted by strip mining. Fragmentation and destruction of potential habitat, however, is evident despite attempts at post-mining land reclamation. Surveys of proposed mining areas are important to ensure occurrences are not impacted.

Invasive exotic species

Invasive exotic species, through deliberate and accidental introduction, are often associated with displacement of native species and decreases in species diversity or richness through their increased competitive ability and effects on ecosystem functioning (Wilson 1989, Wilson and Belcher 1989, Reader *et al.* 1994, Christian and Wilson 1999, Bakker and Wilson 2001, Henderson 2005, Henderson and Naeth 2005). Because buffalograss appears to be limited to areas with little shade and reduced competition from taller species, invasion by taller exotics, such as crested wheatgrass (*Agropyron cristatum*), Kentucky bluegrass (*Poa pratensis*) and smooth brome (*Bromus inermis*), would pose a threat (Wu and Harivandi 1995, Harms in press). Stoloniferous and less productive plants, like buffalograss, tend not to persist in areas with more productive dense grass (Richard and Redente 1995). The encroachment of crested wheatgrass, smooth brome and Kentucky bluegrass is a threat to buffalograss in Saskatchewan; Kentucky bluegrass is a dominant species within the Buffalograss Ecological Reserve in Saskatchewan likely due to the lack of grazing and management. Leafy spurge, an invasive exotic Eurasian species, is thought to be a major threat to buffalograss in Manitoba. Leafy spurge reduces the abundance of native species in areas where it occurs through direct competition (Wilson and Belcher 1989), and has been rapidly expanding through the Souris and Blind River valleys in recent years (Foster and Hamel 2006). Crested wheatgrass, smooth brome, and Kentucky bluegrass have been recorded at some buffalograss sites in Manitoba (Reimer *et al*. 2003, Manitoba Conservation Data Centre, unpubl. data). Controlling the abundance and further spread of these invasive exotic species is critical for the survival of buffalograss; however, care must be taken that buffalograss is not harmed, or its habitat negatively altered, by indiscriminate use of any herbicides used to control invasive species.

Lack of Grazing and/or Alteration to Fire Regime

Prairie plants evolved with the ecological processes of fire and grazing which were important for maintaining ecosystem function. Post-European settlement reduced both the frequency and extent of prairie fires, and variability in grazing patterns, which has collectively changed the structure and composition of many plant communities (Higgins *et al*. 1989, Frank *et al*. 1998,

Brockway *et al.* 2002). Historically, buffalograss adapted to fire and grazing by evolving structures, such as hardened burs, which protect the enclosed seeds from heat damage and aid in endozootic dispersal (Ahring and Todd 1977, Wright and Bailey 1982, Quinn *et al.* 1994, Ford 1999).

The impact of fire on buffalograss appears largely dependent on precipitation, seasonality, and the time since the last fire (Higgins *et al.* 1989, Ford 1999). Because buffalograss is a late-developing, warm season grass (C_4), a fire during the growing season kills actively growing leaves. Buffalograss cannot reallocate its energy reserves to produce more leaves before the end of the season, significantly reducing its cover for up to two years post-fire (Brockway *et al.* 2002, Ford 2003, Ford and Johnson 2006). Fire during the dormant season (e.g., fall, winter) has been found to have little effect on buffalograss cover because aboveground tissues are already dead (Ford 1999, Ford 2003, Ford and Johnson 2006). Fires that occur during dry years also appear to elicit at least an initial negative response by buffalograss as the plants may already be under physiological stress. It can take over three years for buffalograss to recover after a dry-season fire (Brockway *et al*. 2002, Ford 2003). A review of studies on buffalograss and fire found that, overall, buffalograss shows a positive to neutral response to fire (Ford 1999). More long-term investigations are needed on the interactions of factors such as drought, season, and fire history, and the mechanisms driving responses. For example, Ford (2003) found greater buffalograss cover in an area that had a growing-season fire than an unburned control area and an area with a dormant-season fire during a drought year five years after the experiment. Studies are also needed on long-term effects of fire on buffalograss and its ecosystem in Canada.

Although Buffalograss still dominates areas where fire or grazing have been excluded (Hulett *et al.* 1972, Howard 1995), a lack of these disturbances can increase litter levels and vegetation height (Hayes and Holl 2003), which can result in reduced growth of short growing and shade intolerant species like buffalograss. Perhaps more importantly, removal of grazing and fire can also increase the susceptibility of rangeland to invasion by weedy species, or less fire-tolerant exotic invasive species (Higgins *et al.* 1989, Milchunas *et al.* 1989, Milchunas *et al.* 1992). Grazing is present on all existing buffalograss sites in Saskatchewan and Manitoba with the exception of the Sourisford Park in Manitoba (but mowing occurs) and the Buffalograss Ecological Reserve in Saskatchewan. Both sites have problems with weedy species, and the ecological reserve is dominated by taller invasive exotic species such as Kentucky bluegrass. Prescribed burns are not a regular practice on any of the sites and wildfires are typically suppressed.

The impact of grazing on buffalograss appears to be positive, as increased grazing intensity has been found to increase buffalograss cover and/or frequency (Herbel and Anderson 1959, Anderson *et al.* 1970, Bonham and Lerwick 1976, Klatt and Hein 1978, Ring *et al.* 1985, Hart and Ashby 1998). A wide range of animals, in addition to cattle, horses and bison, are known to eat buffalograss, including deer, elk, pronghorn antelope, white-tailed jackrabbit (*Lepus townsendii*), black-tailed prairie dog (*Cynomys ludovicianus*), upland game birds and various small mammals (see Howard 1995). Buffalograss appears tolerant of moderate to heavy grazing, and may have an advantage by rapidly spreading vegetatively once grazing has reduced competitors, particularly taller grasses. As with fire effects, buffalograss can withstand more defoliation during periods of dormancy than periods of active growth (Vallantine 1990).

Nevertheless, its deepset root crowns seem resistant to trampling by ungulates, making buffalograss quite hardy even during active growing periods (Young 1956).

Small Catchment Dams and Dugouts

Small catchment dams and associated dugouts have been placed in the bottoms of coulees to retain runoff water for consumption by cattle. Harms (1997) estimated that these have eliminated a 300 m extent of buffalograss habitat in coulee bottoms. Buffalograss has been observed growing in a ring surrounding a dugout; however, it is not known whether the buffalograss grew here prior to dugout construction, or if it was transported here by cattle using the dugout, and then became established due to the favourable microsite conditions created by high cattle traffic (i.e., trampled, bare clay with high moisture and high nutrient availability, low competition, warm temperature) (C. Neufeld, unpubl. data).

Flooding by Exising Large-scale Reservoirs/Dams

Changes to the moisture regime at a site could adversely affect buffalograss growth and survival. As most of the buffalograss sites occur on lower slopes of valley and coulee walls, any prolonged inundation of these areas resulting from developments or disturbances that cause unnatural flooding, inhibit channel migration, or divert water could alter the disturbance regime beyond the range of natural variability, negatively impacting the creation and maintenance of buffalograss habitat. The creation of the Rafferty and Boundary Dams and Reservoirs in Saskatchewan flooded a considerable area of habitat along the Souris River Valley, where populations of buffalograss likely occurred. Sites that currently exist adjacent to the Rafferty reservoir may be at risk in years when water levels rise (Harms in press). To date, no dams have been built in Manitoba that affect populations of buffalograss, although dam 357 on the Souris River in North Dakota, upstream of Buffalograss sites in Manitoba may have been a seed source before that area was flooded (Reimer *et al.* 2003).

Cultivation

Less than 20% of the mixed grass prairie in Manitoba, and 31.3 % of that in Saskatchewan is estimated to remain uncultivated (Gauthier *et. al*. 2002, Nernberg and Ingstrup 2005). The remaining native prairie is fragmented, and most remnant patches are small and isolated from other patches by cropland (James *et al.* 1999), which threatens natural patterns of seed dispersal and gene flow within former populations and between extant populations. The threat of cultivation is more historic than current, with most of the damage already having occurred. Remaining uncultivated prairie where buffalograss occurs will likely not be broken for agriculture as the soils are generally unsuitable for cultivation. In Manitoba, buffalograss grows on soils that have severe limitations for crops due to soil structure, low permeability and presence of soluble salts (Eilers *et al.* 1978). In Saskatchewan, soils with buffalograss are suited only for grazing due to their shallow nature, bedrock exposures, and dissected terrain. A few buffalograss sites have suitable agricultural soils, but they occur in irregular bands in valleys which is less feasible tillage (Saskatchewan Soil Survey 1997). Additionally, the topography of sites located on valley walls or dissected coulee bottoms is not conducive to cultivation. The use of some chemicals (e.g., herbicides, fertilizer, pesticides) on adjacent cultivated areas has the

potential to alter habitat on the native prairie as well (e.g., change species composition, canopy cover, hydrology, and soil stability, degrade pollinator populations). Cultivation has likely reduced overall habitat availability, population size, and genetic diversity of this species to the point where parts of its historical range may have been destroyed, and larger expansion of its current range is no longer possible.

Road Construction or Upgrades

Road construction has likely impacted buffalograss populations in the past. Highway 18 in Saskatchewan, heading west from Estevan, dissects buffalograss occurrences, which now exist adjacent to the highway ditches (Harms in press, C. Neufeld, pers. obs.). These fragmented occurrences were likely joined prior to the construction of that highway. Similarly, highway 251 and an abandoned railbed dissect buffalograss populations near Coulter, Manitoba (Harms in press). Buffalograss is occasionally found along vehicle track trails, where it seems to take advantage of decreased competition. Upgrades to these roads will destroy the buffalograss clones growing along them (Harms in press). Roads can also change the hydrology of habitat by modifying drainage patterns and water flow in an area.

Urban expansion

In Saskatchewan, locations of buffalograss have been found within one kilometer of the Estevan city limits. There also may be suitable habitat closer to the city, or undeveloped land within city limits which is already supporting buffalograss. Future growth of Estevan, particularly acreages on the outskirts of town, could threaten existing buffalograss sites, or further reduce remaining suitable habitat.

Clay-pit mining

Clay-pit mining historically occurred in the area, and at least two mines are in close proximity to existing buffalograss sites (Harms in press, C. Neufeld pers. obs.). Although these mines appear to be abandoned and should not pose a future threat, it is possible that some buffalograss was destroyed in the past by one of these mines, as evident by buffalograss currently occurring adjacent to the pit. There is revised interest in mining clay in southern Saskatchewan as an additive in specialized concrete mixes (S. McAdam, pers. comm.).

1.7 Knowledge Gaps

Knowledge gaps for buffalograss are identified in section 2.4 Recovery Objectives, section 2.5 Approaches Recommended to Meet Recovery Objectives, and Table 2, and include a need for:

1) Standardized guidelines for buffalograss inventory and monitoring.
2) Complete extent of occurrence, and more accurate and precise knowledge regarding the area of occupancy for buffalograss in Canada.
3) Population trends, including reproduction and mortality rates, to better understand the population viability of buffalograss in Canada.
4) Habitat associations and critical habitat identification for buffalograss in Canada.

5) Genetic similarity and magnitude of isolation effects of Canadian buffalograss populations relative to each other, and to nearby populations in the U.S.A.

2. RECOVERY

2.1 Recovery Feasibility

The recovery of buffalograss in Canada is considered feasible because 1) individuals capable of reproduction are available; 2) sufficient suitable habitat is available or could be made available through habitat management; 3) some of the significant threats to the species can be mitigated through stewardship agreements and beneficial management practices; and 4) the techniques for effective recovery appear achievable.

2.2 Recovery Goal

The recovery goal for buffalograss is to maintain the persistence of all naturally[4] occurring populations in Canada.

The status of this species is not likely to be down-listed from threatened based on COSEWIC assessment criteria for populations having a very restricted area of occupancy or number of locations which put it at risk of being impacted by human activities or stochastic events (COSEWIC 2006). Nevertheless, it should be feasible to maintain this species under the normal range of environmental conditions with successful management of threats, implementation of stewardship agreements and beneficial management practices. Therefore, in the absence of information documenting the full area of occupancy and monitoring data to demonstrate a trend, the maintenance of populations and their habitat will define the recovery of buffalograss.

2.3 Population and Distribution Objective(s)

A numeric population objective cannot be described for this species. Buffalograss is a clonal species which forms patches containing hundreds or thousands of individuals which would not be feasible to count. The clonal patches often merge with other patches because of the stoloniferous nature, resulting in large, dense mats. This makes it impossible to distinguish and count individual clones. Further complications arise because burs often drop below the female plant, and new individuals can then grow very close to the parent plant, and soon thereafter form their own clone. Therefore, only distribution objectives will be set for this species.

The distribution objectives for this species will be set at two scales. At a finer scale, the distribution objectives will be based on buffalograss patch sizes, or the area of occupancy. At a coarser scale, the distribution objectives will be based on the number of quarter-sections in

[4] Naturally occurring population refers to any population within the native range on naturally occurring habitat. It excludes horticultural populations or those that are dispersed by humans and establish themselves outside the native range or on unnatural habitats.

which buffalograss has been confirmed[5], to represent a biologically relevant unit where soil, vegetation and management practices overlap and contribute to the occurrence of this species.

The area of occupancy of known buffalograss occurrences has not been determined for all of the quarter-sections in which it occurs. Also, new sites in additional quarter-sections are likely to be found with future survey effort. Nevertheless, we have established minimum area objectives. These should be viewed as short-term objectives (5 years) until more detailed mapping, surveying, and monitoring, allow refinement to more accurately represent the area of occupancy.

1) Saskatchewan - Estevan population: Maintain at least 1.27 hectares in at least 17 quarter-sections.
2) Manitoba - Souris River population: Maintain at least 402 hectares in approximately 43 quarter-sections.
3) Manitoba - Sourisford Park population: Maintain at least 0.01 hectares (136 m^2) in at least 1 quarter-section.
4) Manitoba - Blind River Valley North (Element occurrence number 6): Maintain at least 4.2 hectares in at least 2 quarter-sections.
5) Manitoba - Blind River Valley South (Element Occurrence Number 5): Maintain at least 0.79 hectares (7974 m^2) in at least 1-2 quarter-sections.
6) Manitoba - Blind River Valley East (Element Occurrence Number 11): Maintain at least 0.01 hectares (137 m^2) in at least 1 quarter-section.

2.4 Recovery Objectives

Objective 1: Develop and promote beneficial management practices and stewardship agreements to land owners, land managers, stakeholders and industry to reduce threats to buffalograss and its habitat by 2012 (Priority – Urgent).

Objective 2: Complete critical habitat identification by 2011 (Priority – Urgent).

Objective 3: Identify extent of occurrence and area of occupancy of buffalograss populations, to the extent possible, by 2012 (Priority - Necessary).

The rationale for objective 3 is based on the limited area of habitat remaining to be surveyed for buffalograss and the relative ease with which this perennial species can detected in the field. Our underlying aim is to proceed with adaptive sampling until we achieve an asymptote where few or no new populations are located as the area searched increases and area remaining to be searched decreases.

Objective 4: Monitor trends in area of occupancy for existing populations through 2017 (Priority - Beneficial).

[5] In Manitoba, the quarter-sections identified are based on polygons that have differing degrees of locational uncertainty as defined by NatureServe standards; therefore, it is possible that some quarter-sections listed may not actually contain buffalograss (C. Foster, pers. comm.).

2.5 Approaches Recommended to Meet Recovery Objectives

The intent of this recovery strategy is to provide a general description of the research and management activities recommended to meet the objectives and address the threats (Table 2). The recovery strategy will be reviewed in five years to evaluate the progress on meeting its objectives and to identify additional approaches and changes that may be required. Performance measures that can be used to evaluate progress in meeting the recovery objectives are included in Table 2. The action plan(s) will contain more detailed information on the actions and the implementation schedule.

Table 2. Recovery Planning Table

Threats addressed	Priority	Broad strategy	Recommended approaches to meet recovery objectives	Performance Measures
Objective 1: Develop and promote beneficial management practices and stewardship agreements to land owners, land managers, stakeholders and industry to reduce threats to buffalograss and its habitat by 2012.				
All threats	Urgent	Stewardship, Outreach, Habitat and Species Protection, Research, Management	• If deemed necessary, initiate research on impact of certain threats and management practices on buffalograss and habitats. • Apply research findings to develop Beneficial Management Practices (BMPs) and recovery action plans for the species. • Communicate beneficial management practices (BMP) and recognize existing supportive land management practices and stewardship of habitat where appropriate. • Establish conservation and stewardship agreements with affected landowners and land managers. • Communicate set-back distance guidelines for disturbances to appropriate regulatory agencies.	• Proposals to apply research findings for developing BMPs will be prepared and submitted to funding agencies by qualified resource management professionals (ongoing 2007-2012). • BMP literature is written, published and distributed in various media appropriate for communicating with affected land owners and land managers (ongoing 2007-2012); this requires review and input by communications experts. • Conservation and stewardship agreement documents meeting SARA criteria of effective protection are in place with affected individuals, resulting in an increase in the proportion of habitat conserved (ongoing 2007-2012); this requires involvement of stewardship agreement brokers from various agencies. • Meeting with regulatory agencies, industries and other stakeholders before 2012 to develop set-back distance guidelines appropriate to the recovery needs of the species and activities of the aforementioned partners. This includes reviewing existing guidelines for efficacy. • Set-back distance guidelines are written, published and distributed in various media appropriate for communicating with affected regulatory agencies, industries and other stakeholders by 2012; this requires review and input by legal and communications experts.

Table 2 (continued). Recovery Planning Table

Threats addressed	Priority	Broad strategy	Recommended approaches to meet recovery objectives	Performance Measures
Objective 2: Complete critical habitat identification by 2011.				
All threats	Urgent	Research, Habitat Protection	• Describe detailed habitat associations in Canada through scientific field investigations. • In support of Population Viability Analyses, a combination of scientific field investigations, in-situ or ex-situ manipulated experiments are needed to determine reproductive and mortality rates, and inter and intra-population genetic diversity. (refer to 2.6.2 Schedule of Studies to Identify Critical Habitat)	• Proposals to conduct field investigations, in-situ or ex-situ manipulated experiments will be prepared and submitted to funding agencies by qualified researchers (2007-2008). • Reports of research findings will be received and reviewed by Recovery Team to refine action plan development by 2011. • Full identification of critical habitat based on research findings, and formalized in an action plan by 2011. • Establishment of an ex-situ seed bank at Plant Gene Resources Canada (Saskatoon) to assist with ongoing research activities involving ex-situ experiments or genetic analyses (ongoing 2007-2012).
Objective 3: Identify extent of occurrence and area of occupancy of buffalograss populations, to the extent possible, by 2012.				
All threats	Necessary	Population inventory	• Develop and apply guidelines to survey for and inventory new occurrences or populations. • Coordinate inventory and monitoring activities through the Recovery Team to ensure effective and efficient use of funds and labour. • Identify additional threats at the new populations.	• Guidelines document is created and adopted by all organizations/agencies doing inventory work on this species (CWS document in progress, completed spring 2007). • Adaptive sampling and monitoring[6] indicates most or all of the populations and their area of occupancy have been located and mapped by 2012.

[6] Adaptive sampling, and other designs like adaptive cluster sampling or stratified adaptive cluster sampling, involve sampling at predetermined locations, and increasing or decreasing sampling effort in surrounding areas depending on the success of encountering the species (Thompson 1990, 1991, Smith *et al*. 2004). Adaptive monitoring continually uses existing monitoring data and applied management and monitoring actions to determine the intensity levels of future monitoring, and where it needs to occur (Ringold *et al*. 1996, Smit 2003).

Table 2 (continued). Recovery Planning Table

Threats addressed	Priority	Broad strategy	Recommended approaches to meet recovery objectives	Performance Measures
Objective 4: Monitor trends in area of occupancy for existing populations through 2017.				
All threats	Beneficial	Population monitoring	• Develop and apply guidelines to monitor existing populations within the metapopulations. • Coordinate monitoring activities through the Recovery Team to ensure effective and efficient use of funds and labour.	• Guidelines document is created and adopted by all organizations/agencies doing monitoring work on this species (CWS document in progress, completed spring 2007). • Adaptive monitoring allows for area of occupancy trend analysis of the Canadian population (ongoing 2007-2017). • COSEWIC Status assessment update results in maintenance, or downlisting (see COSEWIC schedule for reassessment).

2.6 Critical Habitat

2.6.1 Identification of the species' critical habitat

Critical habitat is defined in the *Species at Risk Act* (Subsection 2(1)) as "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species".

The majority of the information available on buffalograss in Canada has only been recently collected and lacks the coverage, quantitative detail, spatial and temporal scale necessary to identify scientifically-defensible and comprehensive critical habitat. The identification of critical habitat will occur following additional survey effort and will be done in one or more action plans. Consultations on critical habitat within the action plans will be required with landowners and lessees, as all known populations of buffalograss occur on private or municipal land in Manitoba and private or provincial crown land in Saskatchewan.

A schedule of studies has been outlined to aid in critical habitat identification and addressing knowledge gaps (see section 2.6.2 Schedule of studies to identify critical habitat). Identification of complete critical habitat will be based on the best scientific information available and expert opinion concerning the species' present and historical range, habitat, biology, and threats. Information reviewed will include known locations, the reason for listing the species, recent biological surveys and reports, peer-reviewed literature, local people and First Nations knowledge, the recovery strategy, and discussions and recommendations from plant experts. Specific locations and land descriptions of critical habitat may be withheld from the Public Registry to protect the species, as well as landowner privacy. Complete critical habitat will be identified with guidance from this recovery strategy as well as guidance from the Recovery Team and will be completed by or before December 2011 as part of the action plan(s).

2.6.2 Schedule of studies to identify critical habitat

Table 2 outlines recommended research and management activities to effect recovery and support the identification of critical habitat. This section outlines specific recommended studies and actions necessary in the identification of complete critical habitat:

1) Collect information on habitat characteristics from known populations, as well as unoccupied sites, using standardized methods suitable for the species, that will be used in developing habitat suitability models. This information may be analyzed using multivariate analysis to identify key factors explaining the occurrence and abundance of buffalograss. Analysis will assist in determining locations and conditions under which critical habitat will be identified (to be completed by 2010).

2) Identify additional suitable habitat, based on geospatial data, expert opinion, and habitat suitability modelling. Survey this habitat for new occurrences using standardized methods suitable for buffalograss (to be completed by 2010).

3) Monitor existing populations to determine trends in area of occupancy, using standardized methods suitable for buffalograss. At least three intervals of monitoring are required for an accurate estimate of trends (to be completed by 2012-2017). Results will be used in population viability analysis (see step 5).

4) Initiate genetic research among populations to determine genetic similarity and magnitude of isolation effects (to be completed by 2011). Results will be used in population viability analysis (see step 5).

5) Perform population viability analyses (PVAs). The PVA will assist in determining which populations are viable and thereby assist in prioritizing critical habitat designation. However, reliable PVAs typically require long-term data sets. Because of dormancy in plants, short-term studies have been found to inflate mortality estimates when used in PVAs (Menges 2000), and long-term experiments are often needed to quantify seed bank dynamics (Reed *et al*. 2002). Therefore, it is unlikely a reliable PVA can be completed in less than 5 years for which there are limited data by the time critical habitat is designated in the action plan(s) by 2011. If this is the case, results from studies completed to date and the precautionary principle will be used to designate critical habitat for the action plan(s). Once enough information has been collected for a PVA, the areas initially designated for critical habitat will be reassessed.

2.7 Effects on Other Species

A few federally listed species at risk may be found in the same general area as buffalograss in Manitoba and Saskatchewan, including the Dakota skipper (*Hesperia dacotae*), Sprague's Pipit (*Anthus spragueii*), Burrowing Owl (*Athene cunicularia*) and the monarch butterfly (*Danaus plexippus)*. In addition, many provincially rare species also occur in these areas including the Baird's Sparrow (*Ammodramus bairdii*), whorled milkweed (*Asclepias verticillata*), whorled milkwort (*Polygala verticillata* var. *isocycla*), prairie bird's-foot trefoil (*Lotus purshianus*), purple coneflower (*Echinacea angustifolia*), and side-oats grama (*Bouteloua curtipendula*), among others (see Harms in press). These species would all benefit from conservation of native prairie, although beneficial management practices differ amongst them.

Management practices, including disturbances such as fire and grazing which would benefit buffalograss, are natural components of prairie ecosystems and may not negatively impact other native species particularly if the timing, intensity and frequency mimic natural processes (Samson and Knopf 1994). As mentioned in section 1.6.2, fire and grazing practices tend to reduce invasive exotic species and some competitively dominant native species, which is usually beneficial to an ecosystem (Higgins *et al.* 1989, Milchunas *et al.* 1989, Milchunas *et al.* 1992). However, in any management plan decisions should be made that benefit all target species and minimize negative effects to non-target native species. Any actions proposed for buffalograss should consider the impact on other species, and should include communication with other recovery teams working in the same area for the most efficient use of resources and to avoid duplication or conflicts with research. The creation of a multiple-species action plan may be beneficial for species inhabiting this ecosystem and should be considered.

2.8 Statement on Action Plans

The action plans for buffalograss will be completed by or before December 2011. Action plans will be completed by jurisdictions with guidance from this recovery strategy and the Recovery Team. There is the potential for a multispecies or an ecosystem-based action plan that could benefit multiple species at risk inhabiting this ecosystem. Steps to achieve recovery as listed in the recovery objectives will be ongoing in the interim.

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