Species at Risk Act
Management Plan Series

Management Plan for the Buffalograss (*Bouteloua dactyloides*) in Canada

Buffalograss

2023

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For copies of the management plan, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

Cover illustration: Candace Neufeld

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[1] www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] 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 management plans for listed species of special concern and are required to report on progress five years after the publication of the final document on the SAR public registry .

The Minister of Environment and Climate Change is the competent ministers under SARA for the Buffalograss and has prepared this management plan as per section 65 of SARA. To the extent possible it has been prepared in cooperation with the province of Manitoba, and the province of Saskatchewan as per section 66(1) of SARA.

Success in the conservation 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 plan and will not be achieved by Environment and Climate Change Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this plan for the benefit of the Buffalograss and Canadian society as a whole.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

[2] www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2

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Executive Summary

Buffalograss (*Bouteloua dactyoides*) is a perennial grass. It reproduces asexually by aboveground stems that root at points along its length to form new plants (stolons), or by underground creeping stems (rhizomes), and sexually by male and female flowers which occur on separate plants. Seeds from the female plant are contained within protective, globular, hardened structures called burs.

In Canada, Buffalograss is restricted to two localized populations. One population is in southeast Saskatchewan and one population is in southwest Manitoba, both associated with the Souris River valley and tributaries.

Currently identified threats of low level impact or higher to Buffalograss are related to habitat loss and degradation from: invasive alien species; mining and quarrying; oil wells and related structures; natural system modifications due to a lack of grazing and/or fire suppression, urban or acreage development; cultivation; road construction and maintenance.

The management objective for Buffalograss is to ensure long-term persistence and natural expansion of all extant native populations in Canada, including any newly located or reconfirmed populations, within the natural range of variability. Broad strategies and conservation measures to address the threats are presented in the section on Broad Strategies and Conservation Measures.

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1. COSEWIC* Species Assessment Information

Date of Assessment: November 2011

Common Name: Buffalograss

Scientific Name: *Bouteloua dactyloides*

COSEWIC Status: Special Concern

Reason for Designation: This grass occurs in limited areas of remnant short-grass prairie in southern Saskatchewan and Manitoba. Threats to this species include coal strip mining, invasive alien plants and overgrowth by woody vegetation and high grass that were once controlled by bison grazing and fire. However, recent survey efforts have increased the known number of populations and it no longer qualifies as a threatened species.

Canadian Occurrence: SK, MB

COSEWIC Status History: Designated Special Concern in April 1998. Status re-examined and designated Threatened in November 2001. Status re-examined and designated Special Concern in November 2011.

* COSEWIC – Committee on the Status of Endangered Wildlife in Canada

2. Species Status Information

In Canada, Buffalograss (*Bouteloua dactyloides*) was listed as special concern under Schedule 1 of the *Species at Risk Act* (SARA) in 2017, having been downlisted from threatened status It is protected in Manitoba where it is listed as threatened under the provincial *Endangered Species and Ecosystem Act*. The conservation status of Buffalograss throughout its range in North America is described in Table 1. In the United States, detailed information is not available on the abundance of Buffalograss, but it is a co-dominant species in the core parts of its range and is considered abundant and widespread. Therefore, the percent of the species' global distribution and abundance currently found in Canada is estimated to be less than 1%, based on its known range.

Table 1. NatureServe[a] conservation status of Buffalograss (NatureServe 2020a).

Global (G) Rank	National (N) Rank	Subnational (S) Rank
G4G5	Canada (N1N2)	Manitoba (S1), Saskatchewan (S1)
	United States (N4N5)	Arizona (S1S2), Arkansas (SNR), Colorado (SNR), Georgia (SNR), Illinois (S2), Iowa (S1), Kansas (SNR), Louisiana (SNR), Minnesota (S3), Missouri (SH), Montana (S4?), Nebraska (SNR), Nevada (SNR), New Mexico (SNR), North Dakota (SNR), Oklahoma (SNR), South Dakota (SNR), Texas (SNR), Utah (S1), Virginia (SNA), Wisconsin (SNR), Wyoming (S3)

[a] *The NatureServe conservation status of a species is designated by a number from 1 to 5, preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global, N = National, and S = Subnational). The numbers have the following meaning: 1 = critically imperiled, 2 = imperiled, 3 = vulnerable, 4 = apparently secure, and 5 = secure. Letters indicate: H = historical, NR =not ranked, NA=not applicable, U=unrankable and ? = inexact or uncertain and qualifies the character immediately before it (NatureServe 2020b).*

3. Species Information

3.1. Species Description

Buffalograss is a member of the grass family (Poaceae). Leaves are grayish-green and curly, about 2-10 cm long and 1-2 mm wide, with fine hairs on the upper and lower surfaces, including a fringe of hair where the leaf meets the stem. This perennial, warm-season (C4) shortgrass is unusual because it can reproduce asexually (vegetatively) by above-ground stems that root at nodes to form new plants (stolons) and horizontal underground stems (rhizomes), as well as sexually by male and female flowers which almost always occur on separate plants (dioecious) (Mueller 1941, Quinn and Engel 1986, Huff and Wu 1992). Male plants have 2 or 3 flowering spikes, with each spike containing many spikelets. Spikelets are arranged in two rows on one side of the spike and each spikelet contains two pollen-bearing grass flowers. 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 flowering spikes superficially resemble flowering spikes of Blue Grama (*Bouteloua gracilis*), and because both species occur in the same habitat, Buffalograss is often overlooked. Female plants have two or three female flowers hidden among the grass leaves, and enclosed in a bur-like structure on a short stalk. Upon maturing, these structures harden into globular, toothed burs containing 1-5 seeds (Looman and Best 1979, Boivin 1981, Quinn and Engel 1986, COSEWIC 2001). 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 (C. Neufeld, pers. obs.).

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). The burs protect seeds from fire or heat damage, desiccation, or animal digestion. 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). At least 50% of burs contain seeds producing both male and female plants (Quinn and Engel 1986, Quinn 1987). Vegetative dispersal occurs mainly by stolons, 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 whereas rhizomes only spread about 0.6 cm per year (Mueller 1941, Quinn 1991, COSEWIC 2001).

3.2. Species Population and Distribution

Global Distribution

Buffalograss is native to North America, ranging from the southern Mexico, through the west interior basin, and south-central and west-central semi-arid prairies of the United States (U.S.), to the temperate semi-arid prairies of Canada (Figure 1). In Canada, Buffalograss is only known to occur in south-east Saskatchewan and south-west Manitoba.

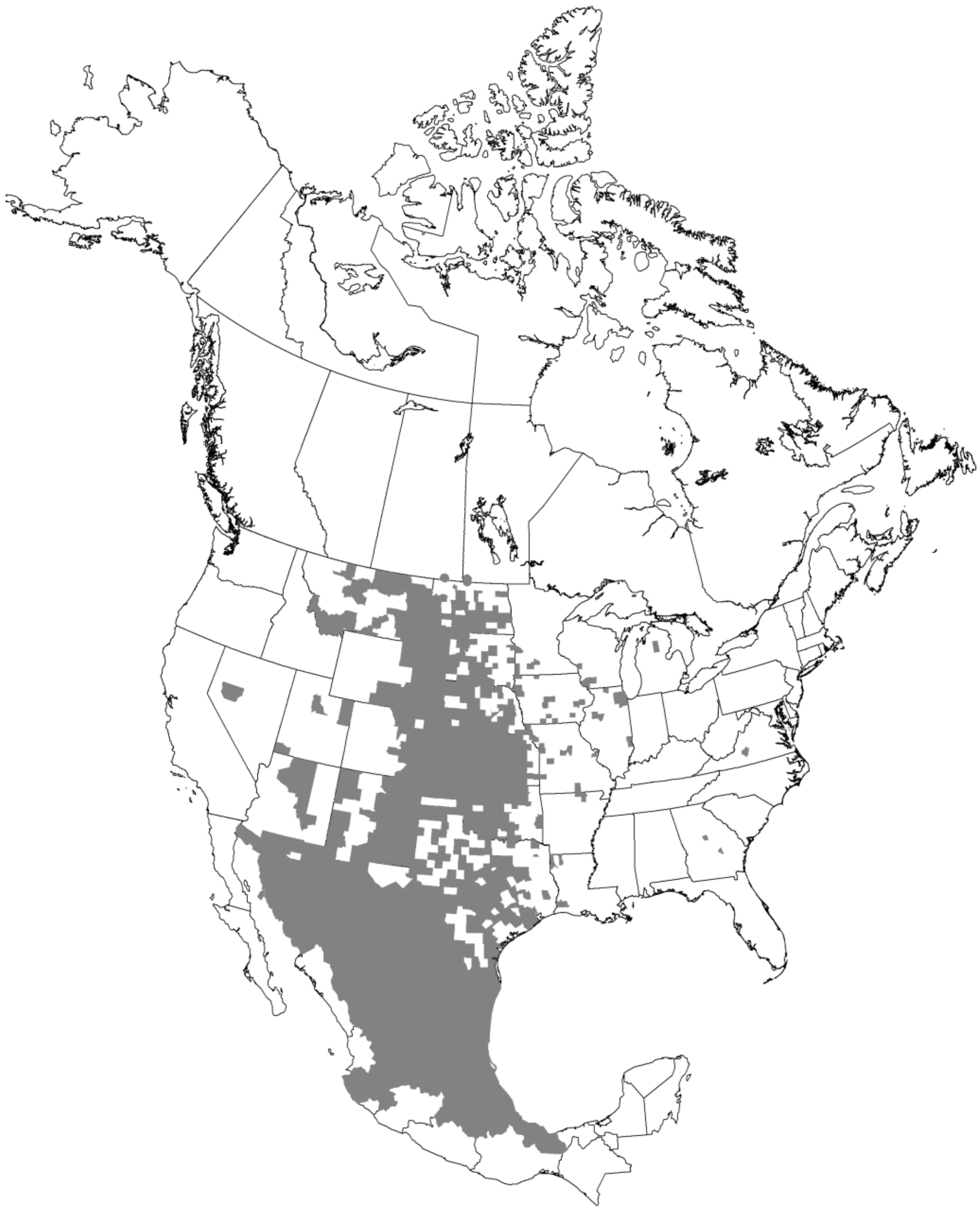

Figure 1. Current distribution of Buffalograss in North America (Kartesz 2015, Villaseñor 2016, Manitoba Conservation Data Centre unpubl. data 2019, Saskatchewan Conservation Data Centre unpubl. data 2019, Pacific Northwest Herbarium unpubl. data 2020, Montana Natural Heritage Program unpubl. data 2020).

Canadian Distribution

In Canada, Buffalograss is restricted to localized areas of Manitoba and Saskatchewan (Figure 2). In Manitoba, there is one extant[3] population[4] which occupies portions of 67 quarter sections in the Souris River Valley and its tributaries (Manitoba Conservation Data Centre, unpubl. data 2019; Appendix A). In Saskatchewan, there is also only one extant population along the Souris River Valley, southwest of Estevan, occupying portions of 27 quarter sections (Saskatchewan Conservation Data Centre, unpubl. data 2019; Appendix A). The full extent of occurrence[5] is not known yet for Saskatchewan but is more well documented in Manitoba. The extent of occurrence was reported in COSEWIC (2011) as 2,383 km^2; however, as the intervening habitat between the Manitoba and Saskatchewan populations is almost all cultivated, the actual extent of occurrence is 138 km^2. The detailed area of occupancy[6] has not been recorded for a large portion of the Buffalograss populations in Manitoba or Saskatchewan; for many quarter sections, only the presence of Buffalograss has been documented. COSEWIC (2011) reported the area of occupancy of Buffalograss in Saskatchewan to be over 0.03 km^2 and in Manitoba to be over 4 km^2; however, both these estimates are very coarse[7]. Future surveying and mapping efforts will increase the known area of occupancy, and additional populations may be discovered in native grasslands in the vicinity of Estevan or elsewhere in Saskatchewan along the U.S. border. Although it is very likely that Buffalograss sites have been lost due to threats like cultivation, strip mining, and urban development, there is insufficient historical and long-term data collected for this species to determine the extent. It is not possible to determine a population trend due to the lack of long-term data on abundance and distribution collected using standardized methods, however, the extent of occurrence has not decreased over time, and due to increased survey effort, it has increased (COSEWIC 2011).

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[3] Extant means the population has been recently verified as still existing, information is accurate, and habitat still exists at the time of writing.
[4] For the purposes of this management plan, a population is defined consistently with COSEWIC (2011) and considered equivalent to an element occurrence as defined by NatureServe (2020c). Populations are comprised of one or more occurrences (patches of plants). The recovery strategy for Buffalograss (Environment Canada 2007), which this management plan replaces, reported 5 populations of Buffalograss in Manitoba; an earlier COSEWIC status report (COSEWIC 2001) also reported multiple populations of Buffalograss in Saskatchewan and Manitoba. However, survey work in Manitoba in the last decade found Buffalograss in additional quarter sections which merged all the previous populations together into one, and is considered a single element occurrence under NatureServe (2020c) guidelines.
[5] 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 2020); however, this often includes large areas of unoccupied and/or unsuitable habitat.
[6] Because 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 it is difficult to accurately count clones. Therefore, its area of occupancy, or the area it covers on the ground (with boundaries mapped with the use of a GPS unit), are often recorded and used as a way to monitor buffalograss.
[7] Because all quarter sections containing Buffalograss have not been thoroughly surveyed and mapped, the area of occupancy estimate sometimes includes the entire quarter section when Buffalograss would only occupy a portion of it, or only includes one patch in a quarter section when Buffalograss would occupy a larger portion within the quarter section.

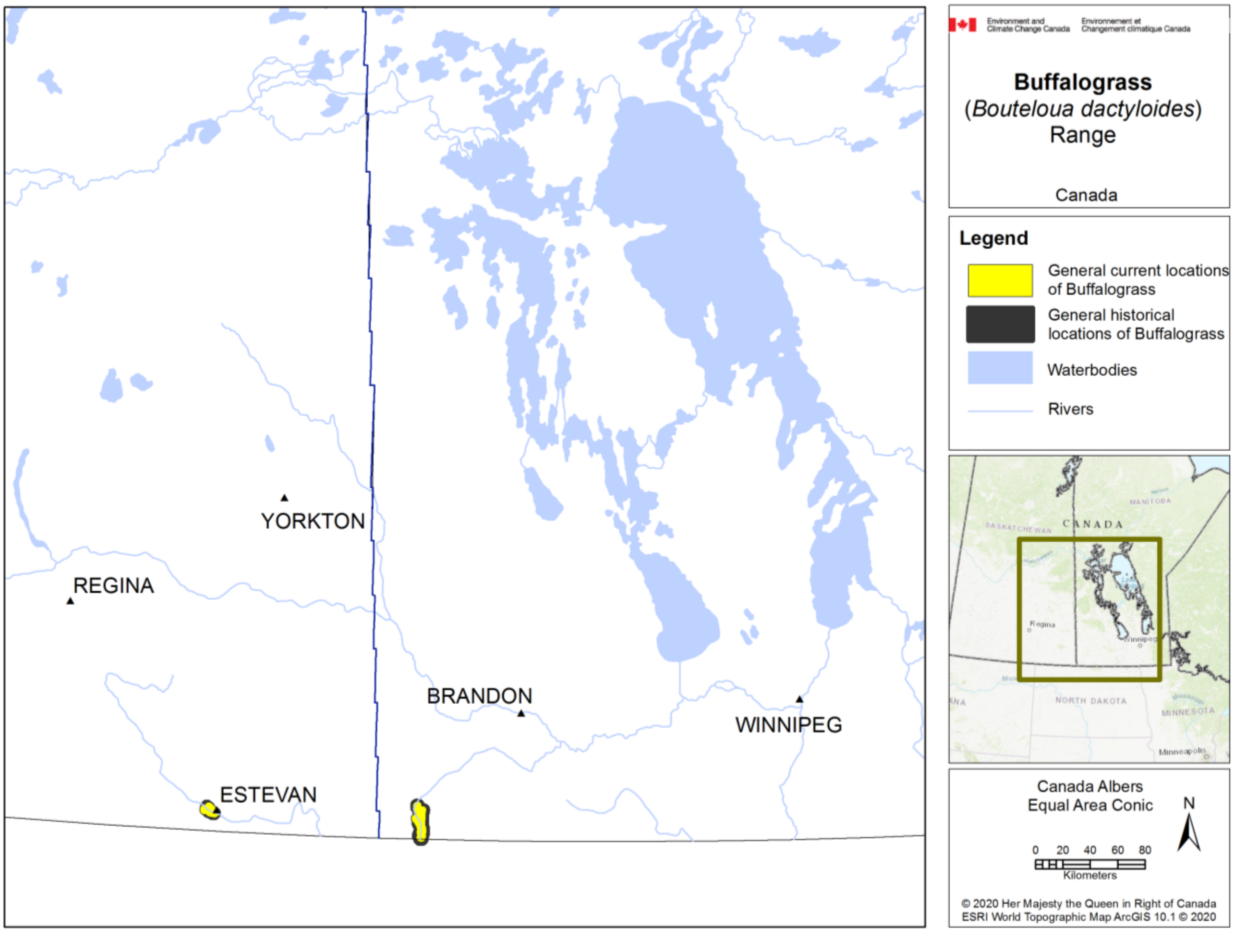

Figure 2. Current distribution of Buffalograss in Canada (compiled from data provided by Manitoba Conservation Data Centre 2019 and Saskatchewan Conservation Data Centre 2019).

3.3. Needs of the Buffalograss

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, Marshall and Schut 1999). 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 (Fung et al. 1999).

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). 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, where it inhabits shale outcrops, dry, shallow coulee bottoms, lower coulee slopes (usually west or south facing), mid-slope benches which may be eroded, and adjacent upland, sometimes in slight depressions or adjacent to soil disturbances like cattle trails (COSEWIC 2001, Reimer et al. 2003, C. Neufeld, pers. obs.). It appears more prevalent on lower slope positions relative to upland summits (Richard and Redente 1995, Reimer et al. 2003, C. Neufeld, pers. obs.), although cattle foraging behavior may explain some of the distribution of Buffalograss in these areas (COSEWIC 2011). On a microsite level, Buffalograss occurs mostly on clay to loam soils with a relatively high moisture and phosphorus availability, and exhibits a high alkali-tolerance (Eilers et al. 1978, Schimel et al. 1985, Bai 1989, Richard and Redente 1995, Reimer et al. 2003, COSEWIC 2011). 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.

In Canada, Buffalograss occurs in grazed rangeland dominated by Blue Grama , Needle-and-thread Grass (*Hesperostipa comata*), June Grass (*Koeleria macrantha*) and Western Wheatgrass (*Pascopyrum smithii*) along with the non-native Kentucky Bluegrass (*Poa pratensis*) (for a more detailed species list, see COSEWIC 2001, Reimer et al. 2003, COSEWIC 2011). 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).

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 to cattle 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, COSEWIC 2001). Acoma and Laguna tribes in the southern United States crushed Buffalograss stolons with Soapweed (*Yucca glauca*) 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).

Limiting factors

As a warm-season perennial grass at the extreme northern edge of its range, Buffalograss is probably limited primarily by growing season length and habitat differences. Warm-season perennial grasses transplanted further north often develop slower and fail to complete reprodu ction (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 (Channell and Lomolino 2000, Vucetich and Waite 2003). This may make them more susceptible to fragmentation effects, such as lower immigration rates and higher extinction rates.

4. Threats

4.1. Threat Assessment

The threat assessment is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system. Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational). Limiting factors are not considered during this assessment process. Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats are presented in the Description of Threats section.

Table 2. Threat Assessment Table.

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]
1	Residential & commercial development	Low	Small	Serious-Slight	High
1.1	Housing & urban areas	Low	Small	Moderate-Slight	High
1.3	Tourism & recreation areas	Negligible	Negligible	Serious-Slight	High
2	Agriculture & aquaculture	Low	Small	Extreme-Serious	High
2.1	Annual & perennial non-timber crops	Low	Small	Extreme-Serious	High
3	Energy production & mining	Medium-Low	Restricted-Small	Serious-Moderate	High
3.1	Oil & gas drilling	Low	Restricted-Small	Slight	High
3.2	Mining & quarrying	Medium-Low	Restricted	Serious-Moderate	High
4	Transportation & service corridors	Low	Small	Moderate	High
4.1	Roads & railroads	Low	Small	Moderate	High
4.2	Utility & service lines	Negligible	Negligible	Slight	High
7	Natural system modifications	Low	Small	Moderate	High
7.1	Fire & fire suppression	Negligible	Pervasive	Negligible	High
7.2	Dams & water management/use	Unknown	Unknown	Unknown	High
7.3	Other ecosystem modifications	Low	Small	Moderate	High
8	Invasive & other problematic species & genes	Medium	Pervasive	Moderate	High
8.1	Invasive non-native/alien species	Medium	Pervasive	Moderate	High
8.2	Problematic native species	Negligible	Small	Negligible	High
11	Climate change & severe weather	Unknown	Large	Unknown	Moderate
11.4	Storms & flooding	Unknown	Large	Unknown	Moderate

[a] ***Impact*** *– The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment timeframe (e.g., timing is insignificant/negligible or low as threat is only considered to be in the past); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.*

[b] ***Scope*** *– Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible < 1%).*

[c] ***Severity*** *– Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible < 1%; Neutral or Potential Benefit ≥ 0%).*

[d] ***Timing*** *– High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.*

4.2. Description of Threats

Loss of habitat quantity and quality among the known populations of Buffalograss may adversely affect the species persistence in Canada. Future loss or degradation of habitat will be partially as a result of threats acting together, acting cumulatively, or acting on their own. Threats are discussed in more detail below in decreasing order based on the Level 1 threat impact. Appendix A (Table A1) identifies the threats associated with each population.

IUCN-CMP Threat 8 - Invasive and Other Problematic Species and Genes (Medium)

8.1 Invasive non-native/alien species (Medium)

Invasive non-native plants can pose a direct threat through competition because they are aggressive and can displace native species, can decrease species diversity or richness through their superior competitive ability, and/or result in overall negative 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, Jordan et al. 2008, Dillemuth et al. 2009, Koper et al. 2010). In the case of Buffalograss, invasive non-native species can also cause shading, and/or a build up of a litter layer with a moisture microclimate that would not be compatible with the dry, unshaded, and shorter vegetation associated with Buffalograss and its habitat (Wu and Harivandi 1995, COSEWIC 2001). Stoloniferous and less productive plants, like Buffalograss, tend not to persist in areas with more productive dense grass (Richard and Redente 1995). The most common invasive non-native plant species occurring in Buffalograss habitat in Saskatchewan and Manitoba (unless otherwise specified), are Leafy Spurge (*Euphorbia esula*), Kentucky Bluegrass (*Poa pratensis*), Crested Wheatgrass (*Agropyron cristatum*), Smooth Brome (*Bromus inermis*), Sweet Clover (*Melilotus* spp.), Canada Thistle (*Cirsium arvense*, SK only), Alfalfa (*Medicago* sp., SK only), Absinthe (*Artemisia absinthium*, SK only), Quack Grass (*Agropyron repens*, MB only) (COSEWIC 2001, Reimer et al. 2003, COSEWIC 2011, Saskatchewan Conservation Data Centre unpubl. data 2019, Manitoba Conservation Data Centre unpub. data 2019). Kentucky Bluegrass has become a dominant species within the Buffalograss Ecological Reserve in Saskatchewan, likely due to the lack of grazing management, but it is prevalent in all quarters containing Buffalograss, being more dense in some quarters than others. Leafy Spurge is thought to be a major threat to Buffalograss and has been rapidly expanding through the Souris and Blind River valleys in Manitoba and has recently appeared in the Saskatchewan population. Leafy Spurge can spread quickly, and with its extensive root systems, can form a dense monoculture stand and produce which reduces the distribution and abundance of other plant species occupying the habitat (Selleck et al. 1962, Belcher and Wilson 1989, Wilson and Belcher 1989, Butler and Cogan 2004). An added concern is that Leafy Spurge is extremely difficult to control by chemical and physical means and produces a milk substance that is an irritant to ungulates (Kronberg et al*.* 1993, Trammell and Butler 1995, Pachkowski 2003, Lesica and Hanna 2004, Crone et al. 2009, Rinella et al. 2009, Progar et al. 2011). Lastly, a few years of monitoring post flooding in areas occupied by Buffalograss found an initial plant community shift to more “weedy” and colonizer species; with an anticipated increase in flood events (threat 11.4) this may continue (Murray 2013, Murray 2014). Controlling the abundance and further spread of all invasive non-native 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 non-native species.

8.2 Problematic native species (Negligible)

Shrubs can invade prairie to where it shades out or outcompetes grasses (Manske 2006). Studies have found fire suppression, certain grazing management practices, and areas in pastures with higher water availability can favour shrub growth (Pelton 1953, Anderson and Bailey 1980, Fitzgerald and Baily 1984, Fitzgerald et al. 1986, Kirby et al. 1988, Higgins et al. 1989b, Bailey et al. 1990, Kochy and Wilson 2004, Manske 2006). Encroachment or increasing abundance of snowberry (*Symphoricarpos* spp.), and to a lesser extent Wolfwillow (*Elaeagnus commutata*) and Chokecherry (*Prunus virginiana*), has been reported in quarters containing Buffalograss in both provinces.

IUCN-CMP Threat 3 - Energy Production and Mining (Medium-Low)

3.1 Oil and gas drilling (Low)

Active and inactive oil wells exist on quarters occupied by Buffalograss in Saskatchewan, mainly in the quarters that fall within the Winnipegosis oil pool (Saskatchewan Mining and Petroleum Geoatlas 2020). The intial impact of drilling the wells would be historical, although some impacts would be ongoing and cumulative (e.g. invasive species introduction on access roads and well pads, road maintenance, fire suppression); these will be considered under the respective threat categories. It is probable that in the future new oil wells will be put on the same quarters as existing wells, or abandoned wells reactivated, or new wells placed in adjacent quarters. The amount of new activity will likely be dependent on oil prices. The areas containing Buffalograss in both Manitoba and Saskachewan hold helium potential, and with the global helium shortage, development of helium wells may become prevalent, particularly due to recent successful test wells in south-western Saskatchewan and an increased interest in this resource in recent years (Yurkowski 2016, Nicolas 2018, Saskatchewan Mining and Petroleum GeoAtlas 2020).

3.2 Mining and quarrying (Medium-Low)

Lignite coal occurs in horizontal beds within the Ravenscrag Formation which extends over the Estevan area in Saskatchewan. Coal is surface mined from large open pits, created by draglines removing topsoil, subsoil, and overlying rock covering the coal seams (Saskatchewan Energy and Mines 1994). The Estevan mine covers over 20,000 ha and has four actively producing pits (Westmoreland Mining LLC 2020, Saskatchewan Mining and Petroleum GeoAtlas 2020). The mine is operating immediately adjacent to existing Buffalograss occurrences. Expansion of strip mining in the direction of existing sites would destroy large portions of the Saskatchewan population. There are also multiple past-producing coal mines in the Estevan area. It is unknown whether any portion of the Saskatchewan population has already been impacted by strip mining but given the large area that has been mined since the 1800s, some of which are adjacent to current Buffalograss occurrences, it is very likely. Fragmentation and destruction of potential habitat is evident in the area. Surveys of proposed mining areas are important to ensure occurrences are not impacted.

In addition to strip coal mining, other forms of mining or quarrying are potential future threats in Buffalograss habitat. Clay (kaolinite) pit mining historically occurred in the area, and at least two historical mines are in close proximity to existing Buffalograss sites (Saskatchewan Mining and Petroleum GeoAtlas 2020). Although these mines appear to be abandoned, it is probable 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 so the mines may become active again. The area has also been explored for kimberlite, diamond, potash, clinker and leonardite but these had lower potential in the area (Saskatchwan Mining and Petroleum Geoatlas 2020). In Manitoba, a few Buffalograss sites are adjacent to old gravel extraction pits.

IUCN-CMP Threat 7 - Natural System Modifications (Low)

7.1 Fire and fire suppression (Negligible)

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. 1989a, 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. 1989a, Ford 1999, Ford 2003). Because Buffalograss is a late-developing, warm season grass, 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. 1989a, Milchunas et al. 1989, Milchunas et al. 1992). Prescribed burns are not a regular practice on any of the occupied sites and wildfires are typically suppressed.

7.2 Dams and water management/use (Unknown)

Changes to the moisture regime at a site could adversely affect Buffalograss growth and survival. Due to widespread cultivation of the upland prairie, most of the remaining Buffalograss sites occur on lower slopes of valley and coulee walls; any prolonged inundation of these areas 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 Buffalograss habitat. Historically, small catchment dams, impoundments and associated dugouts have been placed in the bottoms of coulees to retain runoff water. In the COSEWIC (2001) report, the author estimated that these have eliminated a 300 m extent of Buffalograss habitat in coulee bottoms. Also, 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. To date, no dams have been built in Manitoba on the Souris or Blind rivers that affect populations of Buffalograss, but a dam exists on the Souris River in North Dakota, upstream of Buffalograss sites in Manitoba, and may have been a seed source before that area was flooded (Reimer et al. 2003). In Manitoba, a river channel was artificially straightened affecting some of the Buffalograss plants that were in the area. Small water control structures, drainage projects and ditch deepening may increase in an attempt to control flooding and water levels as a result of increased flood events (threat 11.4).

7.3 Other ecosystem modifications (Low)

Over its North American range, Buffalograss appears in prairies that are in a state of succession or disclimax (a plant community kept from reaching the final "climax condition" due to natural disturbances of grazing and fire) (Clements 1934, Costello 1944, Osborn 1949, Andelt et al. 1987). At its northernmost range limit in southeastern Saskatchewan and southwestern Manitoba, it is limited to shaley-clayey soils, and unshaded habitat with little competition from taller species. Cattle grazing, which somewhat replicates historical bison grazing, is essential in maintaining suitable habitat for Buffalograss by reducing surrounding vegetation height, reducing litter levels (litter accumulation can suppress germination), and managing invasive plant species (Hart and Ashby 1998, Higgins et al. 1989a, Milchunas et al. 1989, Milchunas et al. 1992, Hayes and Holl 2003). 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). Buffalograss appears tolerant of moderate to heavy grazing, and may have an advantage over other grasses by rapidly spreading vegetatively once grazing has reduced competitors. It has evolved deepset root crowns which seem resistant to trampling by ungulates, making Buffalograss quite hardy even during active growing periods (Young 1956). Grazing also aids in dispersal of seed-containing burs, either through attachment to fur or through the digestive tract, the latter of which also increases germination rates (Quinn et al. 1994, Ortmann et al. 1998). In the absence of these grazing animals to disperse seeds, 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. Grazing is absent in Sourisford Park in Manitoba (mowing occurs) and the Buffalograss Ecological Reserve in Saskatchewan. Both sites have problems with invasive species, and the ecological reserve is dominated by taller invasive species such as Kentucky Bluegrass and Crested Wheatgrass. Grazing on other properties with Buffalograss in Saskatchewan and Manitoba varies in frequency, intensity, and duration and some may not be at levels suitable to maintain ideal Buffalograss habitat, as indicated by observations on some quarters where grazing levels were not sufficient (Saskatchewan Conservation Data Centre, unpubl. data 2019).

IUCN-CMP Threat 1 – Residential and Commercial Development (Low)

1.1 Housing and urban areas (Low)

In Saskatchewan, the entirety of the known population is within 10 km of city limits and locations of Buffalograss have been found within one kilometer of the city. Future growth of the city, or placement of acreages on the west and southwest sides of Estevan, may destroy existing Buffalograss sites, or further reduce or degrade remaining suitable habitat. Issues with a landowner stockpiling old farm materials from the yard onto adjacent prairie and Buffalograss plants was reported from one acreage. It is possible some Buffalograss was lost during the development of Estevan, but no historical records exist to document this.

1.3 Tourism and recreation areas (Negligible)

A small campground in Manitoba has maintenance and improvement practices that may threaten the Buffalograss that occurs on the quarter section. These include frequent mowing (reduces reproductive structures and can scalp the grass, but maintains habitat), tree planting (creates shade), and campground site maintenance/ upgrades/expansion, and road maintenance/upgrades/expansion.

IUCN-CMP Threat 2 - Agriculture and Aquaculture (Low)

2.1 Annual and perennial non-timber crops (Low)

The threat of cultivation is mostly historical. 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.The majority of land surrounding the two Buffalograss populations is cultivated. While there still remains cultivatable land occupied by Buffalograss (COSEWIC 2011), a large portion of the remaining uncultivated prairie where Buffalograss occurs will likely not be cultivated due to topography and soil conditions. 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 more suited 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 where tilliage is less feasible (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 herbicides on adjacent cultivated areas has the potential to alter habitat on the native prairie, particularly where there is herbicide drift or run-off (e.g. change species composition, canopy cover, hydrology, and soil stability). Encroachment of invasive species or tame forage species from adjacent cultivated or tame fields is also a threat to habitat quality and persistence of Buffalograss plants (threat 8.1).

IUCN-CMP Threat 4 – Transportation and Service Corridors (Low)

4.1 Roads and railroads (Low)

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. These fragmented occurrences were likely joined prior to the construction of that highway (COSEWIC 2001). Similarly, highway 251 and an abandoned railbed dissect Buffalograss populations near Coulter, Manitoba. Buffalograss is occasionally found along, or adjacent to, vehicle track trails where it seems to take advantage of decreased competition. Upgrades to these roads could destroy the Buffalograss clones growing along them (COSEWIC 2011). In general, habitat and plants can be damaged or destroyed by road construction or maintenance activities such as road widening, grading, ditch deepening, trenching, drainage projects, and realigning or improving the road. In Manitoba, construction of a new road paralleling the Souris River valley, south of highway 251, could impact plants in 10 quarter sections. Road upgrades along highway 251 and highway 3 could also impact portions of the population in 10 quarter sections. In Saskatchewan, upgrades to, or construction along, highway 18, or any of the secondary or gravel roads adjacent to Buffalograss patches, could impact upwards of 20 quarter sections. Roads can also change the hydrology of habitat by modifying drainage patterns and water flow in an area. The linear disturbances created from roads also increase the potential for introduction and invasion by invasive non-native species which may compete with Buffalograss (threat 8.2).

4.2 Utility and service lines (Negligible)

Pipelines carrying crude oil, natural gas, and effluent are in 14 quarter sections in SK. Since these are already installed, they would be be considered historic, although there would be ongoing impacts like invasive species (8.1), and the potential for leaks or ruptures. Additional pipelines or pipeline upgrades might be installed in future if more oil drilling occurs in the area. Utility or other service lines may also be put in if acreage development continues.

IUCN-CMP Threat 11 - Climate Change and Severe Weather (Unknown)

11.4 Storms and flooding (Unknown)

A substantial increase of flooding in the Souris River Basin has occurred since the 1970s (Nustad et al. 2016). Taking into account past climate record and trends in how the Souris River Basin responds to various climatic conditions and extreme precipitation events, statistical models predict the flood risk will remain high as long as the wet climate period continues (Whittrock 2016, Nustad et al. 2016, Ryberg et al. 2016, Gregory 2020). One study led by the United States Geological Survey predicted a 30% chance of the Raferty Reservoir capacity being exceeded at least once in the next 10 years in the current wet climate state (Nustad et al. 2016). As there are still a lot of unknowns regarding impacts of climate change, research and modeling continues in order to gain a better understanding the probability of future flooding and drought scenarios under a new climate regime (Gregory 2020). Buffalograss survived being submerged under flood waters for at least five weeks during a seasonal flooding event in the United States (Parks 1993). Buffalograss also persisted in Manitoba when some of the area it occupies was flooded in 2009 and 2011 for part of the growing season; however, the flood left large amounts of debris and fibrous material and an initial change in species composition occurred (monitoring has not continued) (Murray 2013, Murray 2014). Based on flood mapping from 2009 and 2011 along the Souris River in Manitoba, about 50% of the quarter sections containing Buffalograss were affected by the flood waters. Extreme flood events appear to be increasing (threat 11.4), but the severity these events will have on Buffalograss populations are unknown (COSEWIC 2011).

5. Management Objective

The management objective for Buffalograss is to ensure long-term persistence and natural expansion of all extant native[8] populations in Canada, including any newly located or reconfirmed[9] populations, within the natural range of variability.

Rationale: There has been an increase in knowledge about the distribution of Buffalograss over the last decade as survey effort has increased, to the result of Buffalograss being downlisted from threatened to special concern in 2011 (COSEWIC 2011). Substantial increases to number of populations or area of occupancy are less likely to be documented in the future given that: 1) the suitable habitat for the species is limited and highly fragmented; 2) the majority of suitable habitat has been surveyed; and 3) the Canadian populations exist at the northern limit of the species' range. However, it is likely that some additional populations will be found with future survey effort. Based on the nature of the continuing threats, it is expected that habitat quality and quantity will continue to decline, and known populations may also decline as a result. Therefore, the management objective has been set in the context of reversing or preventing further declines in quality and quantity of habitat through beneficial management practices and stewardship arrangements in order to maintain, and if possible, increase existing populations over the long term.

6. Broad Strategies and Conservation Measures

6.1. Actions Already Completed or Currently Underway

Inventory and Monitoring

In Manitoba, Manitoba Conservation (Conservation Data Centre), along with other botanists, have conducted targeted or incidental surveys for Buffalograss since 1993 when first observed (Reimer and Hamel 2002, Foster and Hamel 2006, Foster and Reimer 2007, Foster 2008, Krause Danielson and Friesen 2009, Murray 2013, Murray 2014, Manitoba Conservation Data Centre unpubl. data 2019). It is likely these surveys and/or monitoring will continue at the Manitoba populations. The Nature Conservancy of Canada is doing habitat modelling to identify priority areas for future inventory work (R. Neufeld, pers. comm. 2020).

In Saskatchewan, Environment and Climate Change Canada, Nature Saskatchewan, Native Plant Society of Saskatchewan, Saskatchewan Research Council and various botanists have conducted targeted surveys for Buffalograss over the last 15 years

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[8] Native 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.
[9] Occurrences that are considered historical or inaccurate (Table A1) are excluded from these objectives until such time as they are reconfirmed.

(Saskatchewan Conservation Data Centre unpubl. data 2019, Environment and Climate Change Canada unpubl. data 2020).

R*esearch as Part of an Adaptive Management Framework*

Nature Conservancy of Canada is investigating the unknown impact of the anticipated increase in future extreme flood events on the Manitoba Buffalograss population. By using data from past flooding events in the Souris and Blind River Valleys, along with Buffalograss occurrence data and LiDAR imagery, they are trying to determine duration and extent of flooding events where Buffalograss occurs, and how this might impact persistence of Buffalograss in these areas (R. Neufeld, pers. comm. 2020).

Habitat Assessment, Management, and Conservation

In Manitoba, Buffalograss is listed as threatened under Manitoba's *Endangered Species and Ecosystem Act*. In Manitoba, habitat containing Buffalograss has been conserved or managed through 20 conservation agreements (easements) and five Species at Risk Partnership on Agricultural Lands (SARPAL) agreements through Manitoba Habitat Heritage Corporation. The Critical Wildlife Habitat Program implemented twice-over grazing management on a property containing Buffalograss in 2011-2013 and monitored results (Murray 2013, Murray 2014).

In Saskatchewan, stewardship agreements have been set up on some properties containing Buffalograss through Nature Saskatchewan. The Native Plant Society of Saskatchewan has created and implemented property-specific beneficial management plans (BMPs) for Buffalograss on properties of landowners with stewardship agreements, which includes adaptive monitoring (assessing the effect of the recommended management activities and making adjustments as needed).

6.2. Broad Strategies

In order to achieve the management objective, conservation measures will be organized under four broad strategies:

- Inventory and monitoring
- Research as part of an adaptive management framework
- Communication, collaboration and engagement
- Habitat assessment, management and conservation

6.3. Conservation Measures

Table 3. Conservation Measures and Implementation Schedule.

Conservation Measure	Priority[a]	Threats[b] or Concerns Addressed	Timeline
Broad Strategy: Inventory and monitoring			
Using consistent survey guidelines (e.g., Henderson 2010), continue surveys to locate new occurrences, particularly in Saskatchewan, and continue to check historical records.	Low	Measure progress towards attaining the management objective.	Ongoing
Using consistent survey guidelines, map the area of occupancy of occurrences where this has not been completed.	Medium	Measure progress towards attaining the management objective.	Ongoing
Using consistent monitoring guidelines, implement a long-term monitoring plan at a subset of populations across the known range collecting information population size and distribution, threats, and habitat trends.	Medium	Measure progress towards attaining the management objective.	Ongoing and at intervals as determined by the plan.
Broad Strategy: Research as part of an adaptive management framework			
Determine long-term impacts of threats and management practices on populations and habitat quality.	Medium	All threats	Ongoing through 2030 or longer
Develop or refine adaptive beneficial management practices (BMPs) for the species (landscape, population, or site-specific may be required) to reduce threats, improve habitat and maintain or increase populations, using knowledge from existing research and assessment of properties.	High	1.1, 1.3, 2.1, 3.1, 3.2, 4.1, 4.2, 7.1, 7.2, 7.3, 8.1, 8.2	Ongoing to 2030
Broad Strategy: Communication, collaboration and engagement			
Develop and promote communication/outreach strategies for land managers and industry to address threats.	Medium	1.1, 1.3, 2.1, 3.1, 3.2, 4.1, 4.2, 7.1, 7.2, 7.3, 8.1, 8.2	Ongoing to 2023
Broad Strategy: Habitat Assessment, management and conservation			
Mitigate the impact of threats to populations and habitat by engaging landowners and land managers in voluntary stewardship agreements, conservation agreements, or fee-simple purchases, especially at high-risk sites; promote or encourage continued stewardship.	High	1.1, 1.3, 2.1, 3.1, 3.2, 4.1, 4.2, 7.1, 7.2, 7.3, 8.1, 8.2	Ongoing through 2030
Monitor and assess conservation agreements and stewardship arrangements in conserving habitat quantity and quality for the species.	Medium		Ongoing and every 3-5 years

Conservation Measure	Priority[a]	Threats[b] or Concerns Addressed	Timeline
Mitigate threats and improve or maintain habitat by encouraging implementation of BMPs; evaluate effectiveness of adaptive BMPs to benefit the species and its habitat.	High		Ongoing, every 3 to 5 years
Integrate habitat management with that for other species at risk or provincially rare species; explore approaches already being used (e.g., Appendix B, Table B1).	Medium		Ongoing through 2030

[a] *"Priority" reflects the degree to which the measure contributes directly to the conservation of the species or is an essential precursor to a measure that contributes to the conservation of the species. High priority measures are considered those most likely to have an immediate and/or direct influence on attaining the management objective for the species. Medium priority measures may have a less immediate or less direct influence on reaching the management objective, but are still important for the management of the population. Low priority* ***conservation*** *measures will likely have an indirect or gradual influence on reaching the management objective, but are considered important contributions to the knowledge base and/or public involvement and acceptance of the species.*

[b] *Threat numbers refer to the IUCN-CMP classification (see Table 2 for full threat names).*

7. Measuring Progress

The performance indicators presented below provide a way to measure progress towards achieving the management objectives and monitoring the implementation of the management plan.

All extant native populations of Buffalograss in Canada, as well as any newly located or reconfirmed populations, are maintained or increased in the long-term.

8. References

Ahring, R.M. and G.W. Todd. 1977. The bur enclosure of the caryopses of Buffalograss as a factor affecting germination. Agronomy Journal 69: 15-17.

Andelt, W.F., Kie, J.G., Knowlton, F.F. and D. Cardwell. 1987. Variation in coyote diets associated with season and successional changes in vegetation. Journal of Wildlife Management 51:273-277.

Anderson, H.G. and A.W. Bailey. 1980. Effects of annual burning on grassland in the aspen parkland of east-central Alberta. Canadian Journal of Botany 58: 985-996.

Anderson, K.L., Smith, E.F. and C.E. Owensby. 1970. Burning bluestem range. Journal of Range Management 23: 81-92.

Bai, T.J. 1989. Association of *Bouteloua gracilis* and *Buchloe dactyloides*. Ph.D. Dissertation, Colorado State University, Fort Collins, Colorado.

Bailey, A.W., Irving, B. and R.D. Fitzgerald. 1990. Regeneration of woody species following burning and grazing in Aspen Parkland. Journal of Range Management 4: 212-215.

Bakker, J. and S. Wilson. 2001. Competitive abilities of introduced and native grasses. Plant Ecology 157: 117-125.

Beetle, A.A. 1950. Buffalograss – native of the short grass plains. Bulletin 293, University of Wyoming Agricultural Experiment Station, Laramie, Wyoming. 31 pp.

Belcher, J. W. and S. D. Wilson. 1989. Leafy spurge and the species composition of a mixed-grass prairie. Journal of Range Management 42:172-175.

Boivin, B. 1981. Flora of the Prairie Provinces: A handbook to the flora of the provinces of Manitoba, Saskatchewan, and Alberta. Part 5, Gramineae, Provancheria 12: 1-107.

Bonham, C.D. and A. Lerwick. 1976. Vegetation changes induced by prairie dogs on shortgrass range. Journal of Range Management 29: 221-225.

Brockway, D.G., Gatewood, R.G., and R.B. Paris. 2002. Restoring fire as an ecological process in shortgrass prairie ecosystems: initial effects of prescribed burning during the dormant and growing seasons. Journal of Ecological Management 65: 135-152.

Butler, J. L. and D. R. Cogan. 2004. Leafy spurge effects on patterns of plant species richness. Journal of Range Management 57:305-311.

Channell R. and M.V. Lomolino. 2000. Dynamic biogeography and conservation of endangered species. Nature. 403: 84–86.

Christian, J.M. and S.D. Wilson. 1999. Long-term ecosystem impacts of an introduced grass in the Northern Great Plains. Ecology 80: 2397-2047.

Clements, F.E. 1934. The relict method in dynamic ecology. Journal of Ecology 22: 39-68.

Coffin, D.P. and W.K. Lauenroth. 1989. Spatial and temporal variation in the seed bank of a semiarid grassland. American Journal of Botany 76: 53-58.

Coffin, D.P., Lauenroth, W.K. and I.C. Burke. 1996. Recovery of vegetation in a semiarid grassland 53 years after disturbance. Ecological Applications 6: 538-555.

COSEWIC. 2001. COSEWIC assessment and status report on the Buffalograss *Buchloë dactyloides* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 29 pp.

COSEWIC. 2011. COSEWIC assessment and status report on the Buffalograss Bouteloua dactyloides in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 39 pp. Website: https://species-registry.canada.ca/index-en.html#/documents/2426 (accessed Feb 11, 2020).

COSEWIC. 2020. Definitions and abbreviations. Website: http://cosewic.ca/index.php/en-ca/about-us/definitions-abbreviations (accessed May 1, 2019).

Costello, D.F. 1944. Natural revegetation of abandoned plowed land in the mixed prairie association of northeastern Colorado. Ecology 25: 312-326.

Crone, E.E., Marler, M. and D.E. Pearson. 2009. Non-target effects of broadleaf herbicide on a native perennial forb: a demographic framework for assessing and minimizing impacts. Journal of Applied Ecology 46:673-682.

Dillemuth, F.P., E.A. Rietschier, and J.T. Cronin. 2009. Patch dynamics of a native grass in relation to the spread of invasive smooth brome (Bromus inermis). Biological Invasions 11: 1381-1391.

Dittberner, P.L. and M.R. Olson. 1983. The plant information network (PIN) data base: Colorado, Montana, North Dakota, Utah and Wyoming. FWS/OBS-83/86. U.S. Department of the Interior, Fish and Wildlife Service.

Eilers, R.G., Hopkins, L.A. and R. E. Smith. 1978. Soils of the Boissevain-Melita area. Soils Report No. 20. Manitoba Department of Agriculture, Winnipeg, Manitoba. 204 pp.

Environment Canada. 2007. Recovery Strategy for the Buffalograss (Buchloe dactyloides) in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. vi + 30 pp. Website: https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/recovery-strategies/buffalograss.html (accessed Aug 20, 2020).

Fitzgerald, R.D. and A.W. Bailey. 1984. Control of aspen regrowth by grazing with cattle. Journal of Range Management 37: 156-158.

Fitzgerald, R.D., Hudson, R.J. and A.W. Bailey. 1986. Grazing preferences of cattle in regenerating aspen forest. Journal of Range Management 39: 13-18.

Ford, P.L. 1999. Response of Buffalograss (*Buchloë dactyloides*) and blue grama (*Bouteloua gracilis*) to fire. Great Plains Research 9:261-276.

Ford, P.L. 2003. Steppe plant response to seasonal fire. Pp. 1125-1131 in Allsopp, N., Palmer, A.R., Milton, S.J., Kirkman, K.P., Kerley, G.I.H., Hurt, C.R. and C.J. Brown (Eds). Proceedings of the VIIth International Rangelands Congress, 26th July-1st August 2003, Durban, South Africa, Document Transformation Technologies.

Ford, P.L. and G.V. Johnson. 2006. Effects of dormant- vs. growing-season fire in shortgrass steppe: biological soil crust and perennial grass responses. Journal of Arid Environments 67: 1-14.

Foster, C. and C. Hamel. 2006. Rare Species Surveys of the Manitoba Conservation Data Centre, 2005. MS Report 06-01. Manitoba Conservation Data Centre, Winnipeg, Manitoba. 43 pp.

Foster, C. and E. Reimer. 2007. Rare Plant Surveys by the Manitoba Conservation Data Centre, 2006. MS Report 07-01. Manitoba Conservation Data Centre, Winnipeg, Manitoba. 53 pp.

Foster, C. 2008. Rare Plant Surveys and Stewardship Activities by the Manitoba Conservation Data Centre, 2007. MS Report 08-01. Manitoba Conservation Data Centre, Winnipeg, Manitoba. 35 pp.

Frank, D.A., McNaughton, S.J. and B.F. Tracy. 1998. The ecology of the Earth's grazing ecosystems. Bioscience 48: 513-521.

Fung, K., B. Barry and M. Wilson. 1999. Atlas of Saskatchewan. University of Saskatchewan, Saskatoon, Saskatchewan. 336 pp.

Gregory, A. 2020. An Investigation of Flood Risk Under a Changing Climate in the Souris River Basin. Paper presented at the joint 34th Conference on Hydrology and 33rd Conference on Climate Variability and Change, Boston, Massachusetts.

Hart, R.H. and M.M. Ashby. 1998. Grazing intensities, vegetation, and heifer gains: 55 years on shortgrass. Journal of Range Management 51: 392-398.

Hayes, G.F. and K.D. Holl. 2003. Cattle grazing impacts on annual forbs and vegetation composition of mesic grasslands in California. Conservation Biology 17: 1694-1702.

Henderson, D.C. 2005. Ecology and Management of Crested Wheatgrass Invasion. Ph.D. Thesis, University of Alberta, Edmonton, Alberta. 137 pp.

Henderson, D.C. 2010. Occupancy Survey Guidelines for Prairie Plant Species at Risk. Environment Canada, Prairie and Northern Region, Canadian Wildlife Service. Edmonton, AB. Website: http://www.npss.sk.ca/docs/2_pdf/Rare_Plant_Occupancy_Survey_Guidelines.pdf (accessed June 3 2020).

Henderson, D.C. and M.A. Naeth. 2005. Multi-scale impacts of crested wheatgrass invasion in mixed-grass prairie. Biological Invasions 7: 639-650.

Herbel, C.H. and K.L. Anderson. 1959. Response of true prairie vegetation on major Flint Hills range sites to grazing treatment. Ecological Monographs 29: 171-186.

Higgins, K.F., Kruse, A.D., and J. L. Piehl. 1989a. Effects of fire in the Northern Great Plains. Extension Circular 761. U.S. Fish and Wildlife Service and Cooperative Extension Service, South Dakota State University, Brookings, South Dakota.

Higgins, K.F., Kruse, A.D. and J.L. Piehl. 1989b. Prescribed burning guidelines in the Northern Great Plains. Extension Circular 760. U.S. Fish and Wildlife Service and Cooperative Extension Service, South Dakota State University, Brookings, South Dakota. 36 p.

Howard, J.L. 1995. *Buchloe dactyloides*. In: Fire Effects Information System, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. Website: https://www.fs.fed.us/database/feis/plants/graminoid/boudac/all.html (accessed May 4, 2020).

Huff, D.R. and L. Wu. 1992. Distribution and inheritance of inconstant sex forms in natural populations of dioecious Buffalograss (*Buchloe dactyloides*). American Journal of Botany 79: 207-215.

Hulett, G.K., Brock, J.H., and J.E. Lester. 1972. Community structure and function in a remnant Kansas prairie. Pp. 104-112 in J.H. Zimmerman (Ed.). Proceedings, 2nd Midwest prairie conference, 1970 September 18-20, University of Wisconsin Arboretum, Madison, WI.

Johnston, A. 1987. Plants and the Blackfoot. Lethbridge Historical Society, Lethbridge, Alberta. 20 pp.

Jones, M.D. and L.C. Newell. 1946. Pollination cycles and pollen dispersal in relation to grass improvement. Nebraska Agricultural Experiment Station Research Bulletin 148, Lincoln.

Jordan, N.R., Larson, D.L. and S.C. Huerd. 2008. Soil modification by invasive plants: effects on native and invasive species of mixed-grass prairies. Biological Invasions 10: 177-190.

Judd, I.B. 1974. Plant succession of old fields in the Dust Bowl. Southwestern Naturalist 19: 227-239.

Kartesz, J.T. (BONAP). 2015. North America Plant Atlas. Chapel Hill, N.C. [maps generated from Kartesz, J.T. 2015. Floristic Synthesis of North America, Version 1.0. Biota of North America Program (BONAP). (in press)]. Website: http://www.bonap.org/napa.html (accessed Jan 12, 2020).

Kirby, D.R., Sturn, G.M., and T.A. Ransom-Nelson. 1988. Effects of grazing on western snowberry communities in North Dakota. Prairie Naturalist 20: 161-169.

Klatt, L.E. and D. Hein. 1978. Vegetative differences among active and abandoned towns of black-tailed prairie dogs (*Cynomys ludovicianus*). Journal of Range Management 31: 315-317.

Kochy, M. and S.D. Wilson. 2004. Semiarid grassland responses to short-term variation in water availability. Plant Ecology 174: 197-203.

Koper, N., Mozel, K.E., and D.C. Henderson. 2010. Recent declines in northern tallgrass prairies and effects of patch structure on community persistence. Biological Conservation 143: 220-229.

Krause Danielsen, A. and C. Friesen. 2009. Rare Plant Surveys and Stewardship Activities by the Manitoba Conservation Data Centre, 2008. Report No. 2008-04. Manitoba Conservation Data Centre, Winnipeg, Manitoba. 31 pp.

Kronberg, S.L., Muntifering, R.B., Ayers, E.L. and C.B. Marlow. 1993. Cattle avoidance of Leafy Spurge: a case of conditioned aversion. Journal of Range Management 46: 364-366.

Lesica, P. and D. Hanna 2004. Indirect effects of biological control on plant diversity vary across sites in Montana grasslands. Conservation Biology 18: 444-454.

Linhart, Y.B. and Grant, M.C. 1996. Evolutionary significance of local genetic differentiation in plants. Annual Review of Ecology and Systematics 27: 237-277.

Looman, J. and K.F. Best. 1979. Budd's flora of the Canadian Prairie Provinces. Research Branch, Agriculture Canada, Publication 1662. Ottawa, Ontario. 863 pp.

Lowe, A.E. 1940. Viability of buffalo grass seeds found in the walls of a sod house. Journal of the American Society of Agronomy 32: 891-893.

Manske, L.L. 2006. Biological management of Western Snowberry. 2006 Annual Report. Dickinson Research Extension Centre, North Dakota State University, ND. Website:

Marshall, I.B. and P.H. Schut. 1999. A national ecological framework for Canada. Ecosystems Science Directorate, Environment Canada and Research Branch, Agriculture and Agri-food Canada, Ottawa, Ontario.

McFarland, M.L., Ueckert, D.N., Hons, F.M. and S. Hartmann. 1994. Selective-placement burial of drilling fluids: effects on soil properties, Buffalograss and fourwing saltbush after 4 years. Journal of Range Management 47: 475-480.

Milchunas, D.G., Lauenroth, W.K., Chapman, P.L. and M.K. Kazempour. 1989. Effects of grazing, topography, and precipitation on the structure of a semiarid grassland. Vegetatio 80:11-23.

Milchunas, D.G., Lauenroth, W.K. and P.L. Chapman. 1992. Plant competition, abiotic, and long- and short-term effects of large herbivores on demography of opportunistic species in a semiarid grassland. Oecologia 92:520-531.

Mintenko, A.S., Smith, S.R. and D.J. Cattani. 2002. Turfgrass evaluation of native grasses for the Northern Great Plains Region. Crop Science 42: 2018-2024.

Mueller, I.M. 1941. An experimental study of rhizomes of certain prairie plants. Ecological Monographs 11: 165-188.

Murray, K. 2013. Preliminary report on Buffalograss monitoring response to twice-over rotational grazing, flooding and fire: update 2012. Critical Wildlife Habitat Program. Winnipeg, MB.

Murray, K. 2014. Summary of Buffalograss monitoring response to twice-over rotational grazing, flooding and fire, RM of Arthur, 2011-2013. Critical Wildlife Habitat Program. Winnipeg, MB.

NatureServe. 2020a. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Website: http://explorer.natureserve.org/ (accessed January 13, 2020).

NatureServe. 2020b. Ranking species occurrences – A generic approach, 11 January 2008. Version 7.1. NatureServe, Arlington, Virginia. Website: http://explorer.natureserve.org/eorankguide.htm (accessed January 13, 2020).

NatureServe. 2020c. Habitat-based Plant Element Occurrence Delimitation Guidance, 1 October 2004. Version 7.1. NatureServe, Arlington, Virginia. Website: http://explorer.natureserve.org/decision_tree.htm (accessed January 13, 2020).
Nicolas, M.P.B. 2018. Summary of helium occurrences in south-western Manitoba. *In*: Report of Activities 2016, Manitoba Growth, Enterprise and Trade, Manitoba Geological Survey. Pp. 110–118. Website: http://www.manitoba.ca/iem/geo/field/roa18pdfs/GS2018-9.pdf (accessed March 25, 2020).

Nustad, R., Kolars, K., Vecchia, A. and K. Ryberg. 2016. 2011 Souris River flood—Will it happen again? U.S. Geological Survey Fact Sheet 2016-3073. North Dakota State Water Commission, United States Geological Survey. 4 p. Website: http://dx.doi.org/10.3133/fs20163073 (accessed March 27, 2020).

Ortmann, J., Schacht, W.H., Stubbendieck, J. and D.R. Brink. 1998. The "foliage is the fruit" hypothesis: complex adaptations in Buffalograss (*Buchloe dactyloides*). American Midland Naturalist 140: 252-263.

Osborn, B. and P.F. Allan. 1949. Vegetation of an abandoned prairie-dog town in tall grass prairie. Ecology. 30: 322-332.

Pachkowski, J. 2003. Bio-control of Leafy Spurge in Support of Recovery of Species at Risk Year III: 2003 Field Research Results. Rural Development Institute Brandon University, Brandon, Manitoba.

Parks, J. 1993. Midwest flood recovery underway, but will take years. TurfGrass Trends 11:10-12.

Pelton, J. 1953. Studies on the life-history of *Symphoricarpos occidentalis* Hook. in Minnesota. Ecological Monographs 23: 17-39.

Potvin, C. 1986. Biomass allocation and phenological differentiation amongst southern and northern populations of the C4 grass *Echinocloa crus-galli*. Journal of Ecology 74: 915-923.

Pozarnsky, T. 1983. Buffalograss: home on the range, but also a turf grass. Rangelands 5: 214-216.

Progar, R., Markin, G., Scarbrough, D., Jorgensen, C.L. and T. Barbouletos. 2011. Observational monitoring of biological control vs. herbicide to suppress Leafy Spurge (Euphorbia esula): for 8 years. In: Proceedings of the 13th International Symposium on Biological Control of Weeds.

Quinn, J.A. 1987. Relationship between synaptospermy and dioecy in the life history strategies of *Buchloe dactyloides* (Gramineae). American Journal of Botany 74: 1167-1172.

Quinn, J.A. 1991. Evolution of dioecy in *Buchloe dactyloides* (Gramineae): tests for sex-specific vegetative characters, ecological differences, and sexual niche-partitioning. American Journal of Botany 78: 481-488.

Quinn, J.A. 1998. Natural expansion of *Buchloe dactyloides* at a disturbed site in New Jersey and its implications for turf and conservation uses. Journal of the Torrey Botanical Society 125: 319-323.

Quinn, J.A. and J.L. Engel. 1986. Life-history strategies and sex ratios for a cultivar and a wild population of *Buchloe dactyloides* (Gramineae). American Journal of Botany 73: 874-881.

Quinn, J.A., Mowrey, D.P., Emanuele, S.M., and R.D.B. Whalley. 1994. The “foliage is the fruit” hypothesis: *Buchloe dacyloides* (Poaceae) and the shortgrass prairie of North America. American Journal of Botany 81: 1545-1554.

Reader, R.J., Wilson, S.D., Belcher, J.W., Wisheu, I., Keddy, P.A., Tilman, D., Morris, E.C., Grace, J.B., McGraw, J.B., Olff, H., Turkington, R., Klein, E., Leung, Y., Shipley, B., van Hulst, R., Johansson, M.E., Nilsson, C., Gurevitch, J., Grigulis, K. and B.E. Beisner. 1994. Plant competition in relation to neighbor biomass: an intercontinental study with *Poa pratensis.* Ecology 75: 1753–1760.

Reimer, E. and C. Hamel. 2002. Rare Species Surveys of the Manitoba Conservation Data Centre, 2001. Manitoba Conservation Data Centre MS Report Number 02-02, Winnipeg, Manitoba. 37 p.

Reimer, E., Hamel, C., and M. Kowalchuk. 2003. Update on the distribution of Buffalograss in southwestern Manitoba. Blue Jay 61: 96-101.

Richard, C.E. and E.F. Redente. 1995. Nitrogen and phosphorus effects on blue grama and Buffalograss interactions. Journal of Range Management 48: 417-422.

Rinella, M.J., Maxwell, B.D., Fay, P.K., Weaver, T. and R. L. Sheley. 2009. Control effort exacerbates invasive-species problem. Ecological Applications 19:155-162.

Ring C.B., Nicholson R.A., and J.L. Launchbaugh. 1985. Vegetational traits of patch grazed rangeland in west-central Kansas. Journal of Range Management 38:51–55

Ryberg, K.R., Vecchia, A.V., Adnan Akyüz, F. and W. Lin. 2016. Tree-ring-based estimates of long-term seasonal precipitation in the Souris River Region of Saskatchewan, North Dakota and Manitoba. Canadian Water Resources Journal 41: 412-428.

Saskatchewan Energy and Mines. 1994. Coal in Saskatchewan. Misc. Report 95-10. Website: https://publications.saskatchewan.ca/#/products/4711 (accessed March 27, 2020).

Saskatchewan Mining and Petroleum GeoAtlas. 2020. Mine Locations, Oil and Gas, Mineral Resource Assessment, Geological Maps and Publications, Resource Maps (Coal Field, Helium Potential, Oil and Gas Pools). Website: https://gisappl.saskatchewan.ca/Html5Ext/index.html?viewer=GeoAtlas (accessed March 27, 2020).

Saskatchewan Soil Survey. 1997. The Soils of the Weyburn and Saskatchewan Portion of the Virden Map Area 62E and 62F, Saskatchewan. Saskatchewan Centre for Soil Research Publication No. S7, University of Saskatchewan, Saskatoon, Saskatchewan.

Schimel, D., Stillwell, M.A. and R.G. Woodmansee. 1985. Biogeochemistry of C, N, and P in a soil catena of the shortgrass steppe. Ecology 66: 276-282.

Selleck, G.W., Coupland, R.T. and C. Frankton. 1962. Leafy spurge in Saskatchewan. Ecological Monographs 32:1-29.

Sieg, C.H., Uresk, D.W. and R.M. Hansen. 1983. Plant-soil relationships on bentonite mine spoils and sagebrush-grassland in the northern High Plains. Journal of Range Management 36: 289-294.

Swank, G.R. 1932. The Ethnobotany of the Acoma and Laguna Indians. M.A. thesis, University of New Mexico, Albuquerque, New Mexico. 34 pp.

Thornburg, A.A. 1982. Plant materials for use on surface-mined lands. SCS-TP-157. Soil Conservation Service, U.S. Department of Agriculture, Washington, D.C.

Trammell, M.A. and J.L. Butler. 1995. Effects of exotic plants on native ungulate use of habitat. Journal of Wildlife Management 59: 808-816.

Villaseñor, J.L. 2016. Checklist of the native vascular plants of Mexico. Revista Mexicana de Biodiversidad 87: 559-902. Website: https://www.redalyc.org/pdf/425/42547314001.pdf (accessed January 17, 2020).

Vogel, W.G. 1981. A guide for revegetating coal minesoils in the eastern United States. General Technical Report NE-68. U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station, Broomall, Pennsylvania.

Vucetich, J.A. and T.A. Waite. 2003. Spatial patterns of demography and genetic processes across the species' range: Null hypotheses for landscape conservation genetics. Conservation Genetics 4: 639-645.

Westmoreland Mining LLC. 2020. Estevan mine – Saskatchewan. Website: https://westmoreland.com/location/estevan-mine-saskatchewan/ (accessed March 26, 2020).

Wiken, E.B. (compiler). 1986. Terrestrial ecozones of Canada. Ecological Land Classification Series No. 19. Environment Canada, Hull, Quebec. 26 pp. + map.

Young, V.A. 1956. The effects of the 1949-1954 drought on the ranges of Texas. Journal of Range Management 9: 139-142.

Yurkowski, M.M. 2016. Helium in southwestern Saskatchewan: accumulation and geological setting. Saskatchewan Ministry of the Economy, Saskatchewan Geological Survey, Open File Report 2016-1. 20p. Website: https://pubsaskdev.blob.core.windows.net/pubsask-prod/94157/94157-Open_File_Report_2016-1_Yurkowski.pdf (accessed March 27, 2020).

Wilson, S.D. 1989. The suppression of native prairie by alien species introduced for revegetation. Landscape and Urban Planning 17: 113-119.

Wilson, S.D. and J.W. Belcher. 1989. Plant and bird communities of native prairie and introduced Eurasian vegetation in Manitoba, Canada. Conservation Biology: 39-44.

Wittrock, V. 2016. Climatic Extremes and the Energy Sector’s Vulnerability: Now and in the Future - Focus on the Canadian Portion of the Souris River Watershed: A Literature Review. Prepared for Environmental Systems Assessment Canada Ltd as part of the Natural Resources Canada Adaptation Platform Energy Working Group. Saskatchewan Research Council (SRC), Saskatoon SK. SRC Publication # 13757-1E16.

Wright, H.A., and A.W. Bailey. 1982. Fire ecology: United States and southern Canada. John Wiley and Sons, Inc. New York, New York. 501 pp.

Wu, L. and A. Harivandi. 1995. Buffalograss response to cold, shade and salinity. California Turfgrass Culture 45: 5-7.

Appendix A: Summary of Buffalograss Populations in Canada

Table A1. Summary of extant Buffalograss populations in Canada.

Population Name (Geographic area; EO_ID)[1]	First Year Observed	Last Year Observed	Total Cumulative Number of Occupied Quarter Sections	Threats
Saskatchewan (Estevan; 5336)	1957	2019	29[2]	1.1, 2.1, 3.1, 3.2, 4.1, 7.1, 7.2, 7.3, 8.1, 8.2, 11.4
Manitoba (Souris River Valley; 3050)	1953	2019	67	1.1, 1.3, 2.1, 3.1, 3.2, 4.1, 7.1, 7.2, 7.3, 8.1, 8.2, 11.4

[1] *EO_ID refers to the element occurrence identification number, as assigned by the Manitoba Conservation Data Centre (MB CDC) and Saskatchewan Conservation Data Centre (SK CDC) to indicate a distinct element occurrence based on NatureServe's habitat-based plant element occurrence delimitation guidance (NatureServe 2020c). For the purposes of this management plan, we are considering an element occurrence to be analogous to a population. Values in the table are those known to Environment and Climate Change Canada as of May 2020 (Murray 2013, Murray 2014, SK CDC unpubl. data 2019, MB CDC unpubl. data 2019, Environment and Climate Change Canada unpubl. data 2019, Manitoba Heritage Habitat Corporation unpubl. data 2020).*

[2] *There is one historical, and likely extirpated, occurrence in one quarter section within this population. Surveys in 2006 and 2009 were unable to relocate the Buffalograss that had been reported in 1993 and it may have been flooded by the Rafferty Dam. However, suitable habitat exists around this record and further surveys are warranted.*

Appendix B: 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*[10]. 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[11] (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that implementation of management plans may 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 management plan itself, but are also summarized below in this statement.

The potential for the management plan to inadvertently lead to adverse effects on other federally listed species that may co-occur or exist in and around areas occupied by Buffalograss (Table B1) was considered. While all these species would benefit from conservation of native prairie, the beneficial management practices may differ amongst them. Management actions intended to maintain native prairie and suitable habitat for Buffalograss may include practices like prescribed burns, grazing, introduced invasive species control, or brush control of encroaching woody vegetation. Although these activities would be aimed at maintaining native grassland, they may have the potential to minimally harm some species, at least in the short term. For the most part, managing for healthy native ecosystems will benefit non-target species, natural communities, or ecological processes. Management actions, including disturbances such as fire and grazing, are natural components of prairie ecosystems. Negative impacts on other species should be minimized if the timing, intensity and frequency of these management actions mimic natural processes (Samson and Knopf 1994). As mentioned in section 4.2, 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. 1989a, Milchunas et al. 1989, Milchunas et al. 1992). However, conservation measures, management actions and beneficial management practices should strive to benefit as many species as possible and the ecological risks of any action must be considered before undertaking them in order to reduce possible negative effects on other species.

[10] www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html
[11] www.fsds-sfdd.ca/index.html#/en/goals/

Table B1. Species at risk which co-occur in and around areas occupied by Buffalograss.

Common Name	Scientific Name	SARA Status	Province
Amphibians			
Great Plains Toad	*Anaxyrus cognatus*	Special Concern	MB
Northern Leopard Frog (Prairie Population)	*Lithobates pipiens*	Special Concern	MB, SK
Western Tiger Salamander (Prairie Population)	*Ambystoma mavortium*	Special Concern	MB, SK
Arthropods			
Dakota Skipper	*Hesperia dacotae*	Endangered	MB, SK
Greenish-white Grasshopper	*Hypochlora alba*	Special Concern	MB, SK
Gypsy Cuckoo Bumble Bee	*Bombus bohemicus*	Endangered	MB, SK
Monarch	*Danaus plexippus*	Special Concern	MB, SK
Nine-spotted Lady Beetle	*Coccinella novemnotata*	Under consideration	MB, SK
Transverse Lady Beetle	*Coccinella transversoguttata*	Under consideration	MB, SK
Birds			
Baird's Sparrow	*Ammodramus bairdii*	Special Concern	MB, SK
Bank Swallow	*Riparia riparia*	Threatened	MB, SK
Bobolink	*Dolichonyx oryzivorus*	Threatened	MB, SK
Burrowing Owl	*Athene cunicularia*	Endangered	SK
Chestnut-collared Longspur	*Calcarius ornatus*	Threatened	MB, SK
Common Nighthawk	*Chordeiles minor*	Threatened	MB, SK
Ferruginous Hawk	*Buteo regalis*	Threatened	MB, SK
Loggerhead Shrike Prairie subspecies	*Lanius ludovicianus excubitorides*	Threatened	MB, SK
Long-billed Curlew	*Numenius americanus*	Special Concern	SK
Short-eared Owl	*Asio flammeus*	Special Concern	MB, SK
Sprague's Pipit	*Anthus spragueii*	Threatened	MB, SK
Mammals			
American Badger taxus subspecies	*Taxidea taxus taxus*	Special Concern	MB, SK
Little Brown Myotis	*Myotis lucifugus*	Endangered	MB, SK
Reptiles			
Snapping Turtle	*Chelydra serpentina*	Special Concern	MB, SK