Species at Risk Act
Management Plan Series

Management Plan for the Baikal Sedge *(Carex sabulosa)* in Canada

Baikal Sedge

2023

Government of Canada
Gouvernement du Canada

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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: Baikal Sedge, Takhini River dunes, Yukon. Photo ©Syd Cannings.

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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 within five years after the publication of the final document on the SAR Public Registry.

The Minister of Environment and Climate Change and Minister responsible for the Parks Canada Agency is the competent minister under SARA for the Baikal Sedge and has prepared this management plan, as per section 65 of SARA. To the extent possible, it has been prepared in cooperation with the government of the Yukon and First Nations, 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, Parks Canada Agency or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this plan for the benefit of the Baikal Sedge 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.

In 2012, Parks Canada Agency and a technical committee made up of representatives of Environment Canada, Environment Yukon, Carcross/Tagish First Nation, Kwanlin Dün First Nation, Ta'an Kwäch'än Council, Champagne and Aishihik First Nations, Kluane First Nation, and White River First Nation developed a Recovery Strategy for this species, but since the species is now listed as Special Concern under the federal *Species at Risk Act*, this Management Plan has been written for this species.

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

Acknowledgments

This management plan was prepared by Rhonda Rosie (consultant), Saleem Dar, and Syd Cannings (Environment and Climate Change Canada, Canadian Wildlife Service (CWS) Northern Region), and was reviewed by Bruce Bennett, Julie Thomas and Thomas Jung (Government of Yukon); and by Roger Brown (Champagne and Aishihik First Nations). Randi Mulder at the Yukon Conservation Data Centre (Environment Yukon) provided species element occurrences.

This plan was based on an earlier recovery strategy written by Kelly Milner (consultant), Pippa Shepherd (Parks Canada Agency), and Jennifer Line (consultant); with contributions by Bill Barrett, Jr. and Leslie Kerr (Carcross/Tagish First Nation), Richard Cherepak, Lloyd Freese, and Patrick Yarnell (Parks Canada Agency); Bruce Bennett, Heather Clarke, Karen Clyde, and Bruce Downie (Government of Yukon); Mike Gill, Lee Mennell, and Wendy Nixon (Canadian Wildlife Service); Michael Jim and Larry Joe (Champagne and Aishihik First Nations), John Meikle and Dave Sembsmoen (Kwanlin Dun First Nation), Geraldine Pope (Kluane First Nation); and Linda Pringle (Carcross).

The threats table is updated from the one created for the 2016 COSEWIC report, with the participation then of Dwayne Lepitzki, Del Meidinger, Bruce Bennett, Thomas Jung, Todd Powell, Saleem Dar, Pippa Sheppard, Nathalie Leclerc, Phil Emerson, John Miekle, Jim Pojar, Eric Lamb, Andy MacKinnon, Michael Jim, and Karen Timm. The February 2021 threats update was completed by Syd Cannings, Bruce Bennett, and Thomas Jung.

Executive Summary

Baikal Sedge was designated as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in May 2005, and listed on Schedule 1 of the Species at Risk Act (SARA) in August 2006. A Recovery Strategy was published in 2012. COSEWIC reassessed the species and designated it Special Concern in April 2016, and it was listed as such under SARA in February 2019.

The Baikal Sedge is found primarily in Asia: in Kazakhstan, southern Siberia, Mongolia, and western China. In North America, it is only known from the Nogahabara Dunes in Alaska and ten dune complexes in the southwestern Yukon. The Canadian population is estimated to be 3.3 to 4.5 million individual clumps—the percentage of the global population contributed by the Canadian population is unknown, but likely small.

The Baikal Sedge is a tufted perennial plant with long rhizomes[3], and usually grows in active or stabilized dunes, typically with >60% sand and sparse vegetation. It can be a dominant plant in the active region of dunes.

The greatest threats facing the Baikal Sedge are dune stabilization and habitat degradation. Displacement of the existing plant community and stabilization by invasive species such as Altai Wild Rye potentially compromise the natural disturbance regime that allows sand dunes to persist. Climate change may bring warmer, wetter growing seasons that could speed up natural vegetation succession and dune stabilization. Human development of dunes is only occurring at the edge of the Carcross dunes; current and proposed developments there have and will continue to alter existing habitat. Recreational vehicles repeatedly damage the vegetation community at some occupied sites; again especially at Carcross.

The objective of this management plan is to maintain the Baikal Sedge in Canada by ensuring the persistence of all extant subpopulations (those known now and any discovered in the future).

Of the conservation measures identified, the highest priority is fostering collaboration among governments (federal, territorial, and Indigenous), industry, land owners and other interested parties to find and implement suitable approaches for protecting the dune habitat of the Baikal Sedge. Research and surveys that provide a better understanding of the sedge's distribution and ecology would support the development of beneficial management practices.

[3] horizontal underground plant stem capable of producing the shoot and root systems of a new plant

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1. COSEWIC* Species Assessment Information

Date of Assessment: May 2016

Common Name (population): Baikal Sedge

Scientific Name: *Carex sabulosa*

COSEWIC Status: Special Concern

Reason for Designation: In Canada, this species is restricted to 16 sites in 10 dune fields in the southwest Yukon. Since the last assessment, 11 new subpopulations have been found and two serious threats have been negated, which reduces the known risk to the Canadian population. However, natural succession is leading to habitat loss; this is exacerbated by fire suppression. Other threats driving recent declines include off-road recreational vehicle use and habitat loss through housing development. Exotic, invasive plants are a serious potential threat resulting in dune stabilization and competitive exclusion.

Canadian Occurrence: Yukon Territory

COSEWIC Status History: Designated Threatened in May 2005. Status re-examined and designated Special Concern in April 2016.

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

2. Species Status Information

Table 1. Conservation Status of the Baikal Sedge (NatureServe 2020).

Global (G) Rank*	National (N) Rank*	Sub-national (S) Rank*	COSEWIC Status	SARA Status
G5	Canada (N3) United States (NNR)	Canada: Yukon (S3) United States: Alaska (S1)	Special Concern (2016)	Special Concern (2019)

*Rank 1– critically imperiled; 2– imperiled; 3- vulnerable to extirpation or extinction; 4- apparently secure; 5– secure; X – presumed extirpated; H – historical/possibly extirpated; NR – status not ranked; U – unrankable

3. Species Information

3.1 Species Description

Baikal Sedge (*Carex sabulosa*) is a tufted perennial plant with long rhizomes, and usually grows in active, shifting dune environments (Figure 1). The stems are 15-35 cm long, weak, arching, with mature fruiting heads often touching the ground.
The 1-3.5 mm wide leaves are thick at the base, greyish-green, flat with margins curled inward, and tapering to a fine tip. The leaves have purplish sheaths and are mostly shorter than the stems. Old, dry basal leaves are usually curled and persistent. The 2-5 cm long inflorescence consists of 3 to 5 spikes. The club-shaped terminal spike has female flowers positioned above the male flowers while the lateral spikes have female flowers only.

Figure 1. Left: Baikal Sedge, Kusawa dunes. Right: Young Baikal Sedge flowers; curly leaves from last year's growth are visible. Takhini River. Inset: Developing fruit, showing balloon-like structures covering the developing seeds. Lower Alsek River dune. Photos: Left: Syd Cannings. Right and inset: Jennifer Line; used with permission.

3.2 Species Population[4] and Distribution

Baikal Sedge is found in two widely separate areas: central Asia (Kazakhstan, southern Siberia, Mongolia, and western China) and northwestern North America (southwestern Yukon and west-central Alaska) (Hultén 1968; Cody 2000; Murray 2002; Wu and Raven 2010; Alaska Natural Heritage Program 2014; Yukon Conservation Data Centre 2018). The only Alaska locality is the Nogahabara Dunes, which are about 1100 km northwest of the Canadian range (Alaska Natural Heritage Program 2014).

[4] The term 'population' here is used as it is in the COSEWIC report, and refers to the entire population of the species within Canada

In Canada, the Baikal Sedge is restricted to sixteen occurrences[5] in ten active dune fields in the southwestern Yukon, from Kluane National Park and Reserve east to Whitehorse, and south to Carcross (Figure 2; Appendix A; Yukon Conservation Data Centre 2019).

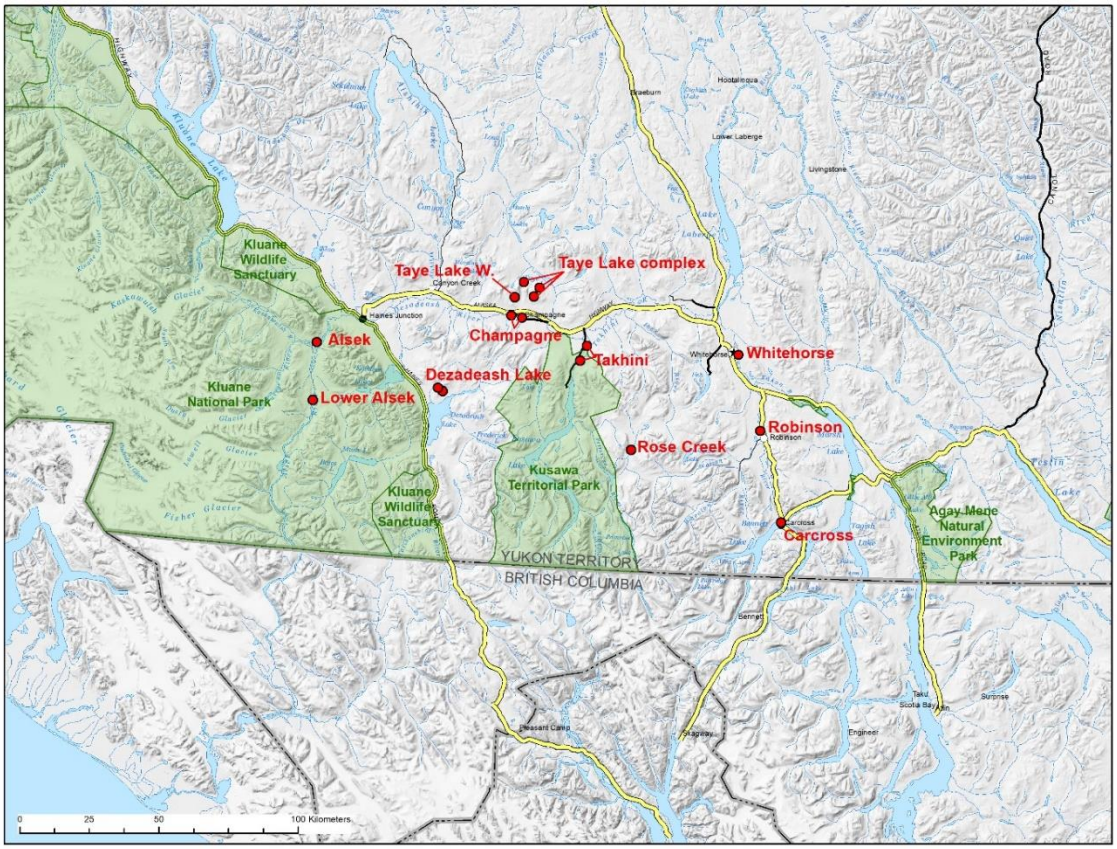
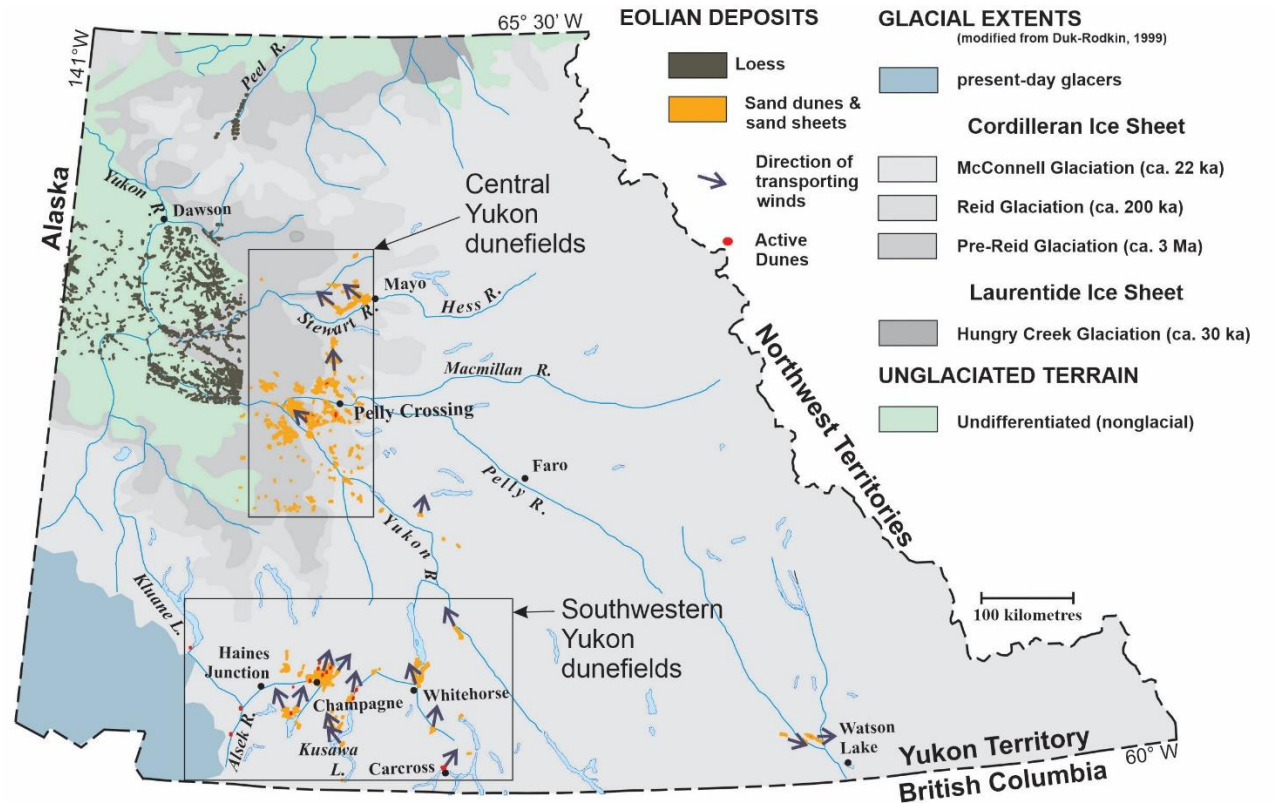


Figure 2. Known occurrences of Baikal Sedge in southwestern Yukon (Appendix A, Yukon Conservation Data Centre 2019). Green polygons represent protected areas.

Baikal Sedge occurs with a number of other northern dune specialist species in an ecosystem that, over the course of the Holocene[6], has shrunk considerably in size and is now rare on the landscape. Most of the remaining dunes are associated with significant sand deposits laid down as the last Pleistocene[7] glaciers melted and poured their sediments into the valleys of southwestern Yukon. The dune fields are restricted in area (Figure 3) and the active dunes within those fields are even more restricted because most dunes do not have access to a continuous supply of sand and are now forested.

[5] The term ‘occurrences’ is used here as it is by the Yukon Conservation Data Centre; that is, they are places that are home to subpopulations separated by more than 1 km.
[6] The current geological epoch, beginning at the end of the last glacial period about 11,650 years ago.
[7] The geological epoch preceeding the Holocene, characterized by a series of glacial advances, or ‘Ice Ages.’



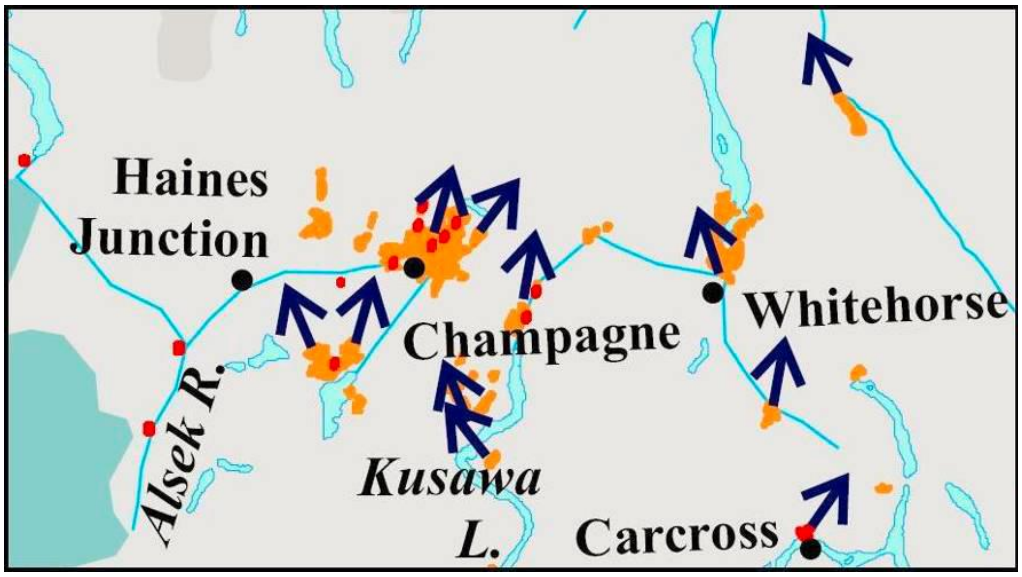


Figure 3. Aeolian deposits of the southern Yukon (lower inset enlarged in separate box). Vegetated, stabilized dunes in orange; active dunes in red; direction of transporting winds marked by arrows. Map from Wolfe et al. (2011).

The estimated number of ramets[8] of Baikal Sedge in all subpopulations is estimated to be >4,500,000, with a lowest subpopulation count of 200 and the highest 3,000,000 (Appendix A). The remaining subpopulation counts ranged from 700 to >600,000 ramets (COSEWIC 2016).

Most of the Baikal Sedge subpopulations are on Crown Land, but three are in parks (two in Kluane National Park and Reserve, one in Kusawa Territorial Park), or in Indigenous settlement lands, or on land privately held by the White Pass and Yukon Railway.

3.3 Needs of the Baikal Sedge

Baikal Sedge needs active, shifting dunes in order to thrive with sand that is loose and deep, usually 0.5 to 4 meters (COSEWIC 2005). The Yukon populations are found in areas close to the coastal mountains and glaciers where strong cold winds consistently blow. These environments are remnants of ice age landscapes when large glaciers and lakes covered much of the region. The winds and cool microclimates, and an abundance of available sand are important for the persistence of these dune environments.

Blowing sand is a common element of Baikal Sedge habitat, and the plant has the ability to send out new clones if older ones get buried. Patches of sedge probably shift location within the dune over time, as blowouts excavate some individuals and moving sand deposits create new habitat. This means that the plant requires the entire, active dune to maintain its population.

Reproduction is little studied but is largely vegetative through rhizomes spreading clones; single clones can cover large areas. Seed production appears to be naturally low: at one site studied only 5% of ramets produced fruit, and about 99% of these fruits were sterile. This was in the absence of a smut fungus infestation that would further limit seed production (see “limiting factors” in Section 4.2 for more information) (COSEWIC 2016).

[8] A ramet is a distinct organism that is part of a group of genetically identical individuals derived from one progenitor; in this case a clump of sedge within a group of clumps that have all sprouted from a single parent plant and are or have been connected by underground rhizomes.

4. Threats

4.1 Threat Assessment

Table 2. Threat calculation for Baikal Sedge. Based on COSEWIC IUCN-CMP Threats Calculator meeting, 14 January 2016; updated in February 2021 (meeting with Syd Cannings, Bruce Bennett, and Thomas Jung). Classification of Threats adopted from IUCN-CMP, Salafsky et al. (2008).

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed threats
1	Residential & commercial development	Low	Small	Extreme	High	
1.1	Housing & urban areas	Low	Small	Extreme	High	Residential development in the Carcross dunes. Scope estimate is closer to the lower end of 'Small'.
1.2	Commercial & industrial areas	Negligible	Negligible	Extreme	High	Small ongoing losses within Carcross townsite. There is a residential/ commercial zone on dunes along shore of Bennett Lake; lower potential for impact near transfer site in Champagne.
1.3	Tourism & recreation areas	Negligible	Negligible	Extreme	Moderate	Potential tourism development in Carcross area
4	Transportation & service corridors	Negligible	Negligible	Extreme	Moderate	
4.1	Roads & railroads	Negligible	Negligible	Extreme	Moderate	Carcross Local Area Plan proposes a new access road to Carcross through the dunes.
6	Human intrusions & disturbance	Low	Large	Slight	High	
6.1	Recreational activities	Low	Large	Slight	High	Repeated travel by all-terrain vehicles can kill sedge and compact sand. Snowmobiles can also compact sand.

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed threats
7	Natural system modifications	Low	Large	Slight	High	
7.1	Fire & fire suppression	Unknown	Large	Unknown	High	Fire suppression increases risk/rate of dune stabilization
7.2	Dams & water management/use	Low	Small	Slight	Moderate	Proposed changes to Southern Lakes water storage; Bennett Lake could have higher water levels in late summer and fall, reducing sand movement into dunes
7.3	Other ecosystem modifications	Low	Small	Slight	High	Stabilization of dunes by native species (not the result of climate change, scored in 11.1), especially the upper Alsek dunes (young dunes without a large supply of sand).
8	Invasive & other problematic species & genes	Unknown	Small-Restricted	Unknown	High	
8.1	Invasive non-native/alien species	Unknown	Small-Restricted	Unknown	High	Altai Wild Rye and White Sweet-clover encroaching edge of Carcross dunes.. Smooth Brome and Quackgrass also of concern. No exotic species at the more remote dunes.
10	Geological events	Negligible	Negligible	Extreme	Moderate-Low	
10.3	Avalanches, landslides	Negligible	Negligible	Extreme	Moderate-Low	There is a possibility of the Lowell Glacier surging and damming the Alsek River again (as it did in the 1850s). However, the resulting lake is unlikely to reach the main Baikal Sedge subpopulations at the confluence of the Kaskawulsh and Dezadeash Rivers, since the mass and depth of the Lowell Glacier has diminished considerably in recent decades.

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed threats
11	Climate change & severe weather	Unknown	Pervasive	Unknown	High	
11.1	Habitat shifting & alteration	Unknown	Pervasive	Unknown	High	Climate change may bring wetter conditions to southern Yukon, which could then increase dune stabilization at smaller sites. Climate warming has caused Kaskawulsh River to 'steal' the watershed of the 'A'äy Chù' (Slims River), and increase greatly in size. This has caused some flooding and erosion near the Alsek Dune population, but is unlikely to reduce the size of these dunes, at least in the short term.

[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

Direct threats to Baikal Sedge assessed in this report are organized and evaluated based on the IUCN-CMP (World Conservation Union-Conservation Measures Partnership) unified threats classification system (Salafsky et al. 2008). Threats are defined as the proximate activities or processes that directly and negatively affect the Baikal Sedge population. Results on the impact, scope, severity, and timing of threats are presented in tabular form in Table 2. The combination of four separate Low impact threats resulted in an overall calculated threat impact of Medium. However, because each of the Low threat impacts was deemed to be at the low end of the range, this calculated overall threat impact rank was adjusted to Low (Appendix 1 in COSEWIC 2016).

Narrative descriptions of the threats are provided below in the order of the IUCN-CMP classification system. Only those threats deemed to be substantive (Low or Unknown impact) are discussed.

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

Residential and commercial development is likely to impact Baikal Sedge, primarily in the vicinity of Carcross.

Threat 1.1. Housing and urban areas (Low Impact)

Current and proposed development in Carcross will continue to alter existing habitat. A residential development has begun in the Carcross dunes, and there is an area zoned Mixed Residential/Commercial in the Local Area Plan (LAP) along the shoreline of Bennett Lake adjacent to this development (Figure 4; Yukon Government and Carcross/Tagish First Nations 2013; Yukon Energy, Mines and Resources 2018). A large, high-density patch of Baikal Sedge north of the town site is on land owned by the White Pass and Yukon Route (WP&YR). This land is designated Residential Development in the LAP. As well, the LAP proposes a new access road that is routed through the dunes (Figure 4).

Figure 4. Carcross development area. Detail from Yukon Energy, Mines and Resources (2018).

Threat 1.2 Commercial and industrial areas (Negligible Impact)

There is a residential/commercial zone mapped on dunes along shore of Bennett Lake (Figure 4).

Threat 1.3 Tourism and recreation areas (Negligible Impact)

In the past, at least two hotel developments have been proposed in the vicinity of the Carcross dunes. While these have not come to fruition, they illustrate the potential growth in tourism and tourist facilities in the immediate area of Carcross.

IUCN-CMP Threat 4. Transportation and Service Corridors (Negligible Impact)

Threat 4.1 Roads and railroads (Negligible Impact)

A second road access to Carcross is in the planning stages, which is intended to help with traffic flow in and out of the community, especially during emergencies (Yukon Government and Carcross/Tagish First Nations 2013). The recommended route would leave the Klondike Highway at the Tagish road junction and swing west and south along the edge of the large Baikal Sedge patch on WP&YR property, joining the new subdivision being developed along the lakefront (Figure 4). The LAP states that “the recommended alternate access route will impact the dune system” and “the significance of these impacts will be considered in discussion with community members” (Yukon Government and Carcross/Tagish First Nations 2013).

IUCN-CMP Threat 6. Human Intrusions and Disturbance (Low Impact)

Threat 6.1 Recreational activities (Low Impact)

The threat of habitat degradation from off-road vehicle use is primarily of concern at Carcross and at the small dune blowouts in Riverdale (Whitehorse) and at Robinson. Heavy, continual use destroys the plants, compacts the sand, and can eliminate Baikal Sedge clones. There is anecdotal evidence that the grass and sedge vegetation on the main Carcross dune along the Klondike highway has declined since the increase in off-road vehicle use in the last 30 years. During this period, up to 12% of the Carcross dune complex has lost vegetation due to motorcycle and ATV activity (COSEWIC 2011).

It is estimated that up to 30 snowmobiles can be using the Carcross dunes during a given winter weekend (COSEWIC 2005). While the snowmobiles are using the dunes primarily when they are covered with snow, they may have a compacting effect. Snow may be quite shallow in certain areas at certain times, and snow machines may damage vegetation in these cases.

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

The persistence of habitat for the Baikal Sedge is dependent on natural disturbance.

Threat 7.1 Fire and fire suppression (Unknown Impact)

No studies have been made on the effects of fire suppression, but it is likely that it will result in accelerated dune stabilization by natural succession, especially where dunes are no longer constantly supplied with additional sand. In Yukon, wild land fire suppression occurs near communities such as Whitehorse, Robinson, Carcross and Champagne. However, even the Takhini River dunes may be subject to fire suppression because of the presence of nearby, occupied cabins.

Threat 7.2 Dams and Water Management/Use (Low Impact)

The movement of beach sand onto the Carcross dunes may be dampened by a proposal to augment hydro power. In order to increase capacity for generating electricity through the winter, Yukon Energy is proposing to accumulate more water behind the Lewes Control Structure by 30 cm more than is currently permitted (Yukon Energy 2017). This means that in a year with low water levels, the water level would be artificially raised to the allowable level by closing the Lewes Control Structure, beginning as early as mid-August. The inundation of the shoreline sand would partially limit the amount of sand blowing into the sand dunes.

Threat 7.3. Other ecosystem modifications (Low Impact)

Dunes were common in Yukon and other northern landscapes during and immediately following the last ice age (Wolfe et al. 2011). Most of these dunes have since been covered by forest through natural succession. As Baikal Sedge roots stabilize the loose sand, other plants are able to establish and eventually out-compete the specialized sedge. Where there isn't a constant supply of fresh sand that can feed the dune-making process (such as at the relatively young Alsek Dunes), this natural stabilization may affect the long-term viability of Baikal Sedge populations.

IUCN-CMP Threat 8. Invasive and other problematic species and genes (Unkown Impact)

Threat 8.1. Invasive non-native/alien species (Unknown Impact)

One of the greatest threats to Baikal Sedge, especially in Carcross, is the establishment of invasive plant species. Dune stabilizers such as Altai Wild Rye (*Leymus angustus*) and Smooth Brome (*Bromus inermis*) are beginning to encroach upon the Carcross dunes (Baikal Sedge Recovery Team 2012; COSEWIC 2016). White Sweet-clover (*Melilotus albus*) was first discovered in the Carcross dunes in 2009; it is also beginning to invade the Dezadeash River corridor and it could move downstream to the subpopulations in Kluane National Park and Reserve (COSEWIC 2016). All three of

these invasive species can thrive in loose sand. Based on the behaviour of these invasive species in Alaska and other jurisdictions, the effects of their establishment at the Yukon dunes could be significant in a very short time (Conn et al. 2008; Baikal Sedge Recovery Team 2012).

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

Threat 11.1 Habitat shifting and alteration (Unknown Impact)

Climate change is predicted to bring warmer, wetter conditions to the southern Yukon, which could increase the speed of dune stabilization, especially at smaller sites. Ryan et al. (2022) summarize the latest projections for the south-central Yukon. Mean annual precipitation in the region is projected to increase by 20-22% by the 2050s; winter, spring and summer precipitation is projected to increase 11-26%, and fall precipitation is projected to increase 35-36%. Precipitation by snow is expected to increase 11-12%. Temperatures are projected to increase 2.5-3.1°C in the summer and fall, and 2.1-2.6°C in the winter and spring. The number of frost-free days is expected to rise by 24-26 days, a 22-24% increase.

Increased summer heat and moisture, and a longer growing season can be expected to accelerate dune stabilization by favouring the ingrowth of plants. However, increased heat can also cause greater evaporation and transpiration, which can reduce the water available to colonizing plants. Increased heat and moisture also increase the number and intensity of thunderstorms and resulting lightning-caused wildfires, which may help keep dunes open, although sparsely-vegetated dunes probably act as a fire break as well. These complex interactions, plus the uncertainty around the climate projections, make assessing the impact of climate change on Baikal Sedge difficult; thus, the assignment of Unknown impact. More study is needed.

Climate warming has also caused the retreat of the Kaskawulsh Glacier, which has allowed the Kaskawulsh River to ‘steal’ the watershed of A’äy Chù (the Slims River), and increase greatly in size. This has caused some flooding and erosion near the upper Alsek Dune population, but is unlikely to reduce the size of these dunes in the short term. If the rate of glacial melt increases dramatically in the longer term, however, flooding may threaten the edges of the Alsek dunes. The lower Alsek dunes are on a raised bench next to the river, and are somewhat protected from increased erosion in the short term.

Limiting factors

Baikal Sedge populations are apparently maintained predominantly through reproduction by rhizomes producing clones (Line and Freese 2006). Production of viable seeds appears to be very limited, and efforts to grow plants from seeds have been unsuccessful (COSEWIC 2016). Thus, dispersal by seeds is probably rare or absent, seriously limiting the colonization or re-colonization of new sites. Single clones can cover a large area, which means there may not be many individual plants. If sexual

reproduction is rare, Yukon subpopulations may have low genetic diversity, and this may make them more vulnerable to environmental change (Line and Freese 2006). However, there is evidence that a high rate of clonal propagation can positively affect genetic diversity, as long as there is clonal diversity initially and monoclonal populations do not develop (Meloni et al. 2013). We need to know, then, how much diversity exists within Baikal Sedge subpopulations now. More research on reproduction and genetics is needed.

Yukon subpopulations of Baikal Sedge are infected by a smut fungus, *Planetella lironis,* which attacks developing achenes (Line and Freese 2006; Line 2011). It is unclear how the fungus affects the overall survival of the plant. This species of smut fungus is very host-specific, suggesting a long-term evolutionary relationship, and there are likely mechanisms in place such that the fungus parasitizes but doesn't kill its host outright. Further research is needed to determine what affects the fungus has on seed production and viability.

5. Management Objective

- To ensure the persistence of all extant subpopulations in Canada (those known now and any newly located or rediscovered subpopulations in the future).

Continuing presence of apparently stable subpopulations at known sites both implies and requires continued habitat extent and integrity[9]. In this case, habitat integrity primarily means continued erosion, movement and deposition of sand across the dunes. At some sites, continued habitat integrity may require mitigation measures to allow ongoing dune movement and reduce the disturbance of the dunes. Zoning and other land use planning measures may also allow for natural dune development in key areas.

6. Broad Strategies and Conservation Measures

6.1 Actions Already Completed or Currently Underway

The following information is from COSEWIC (2016) unless otherwise indicated.

Inventory:

- 2006: Parks Canada-NatureServe Yukon survey along ’A’äy Chù’ (Slims River), and the Kaskawulsh, Dezadeash, and Alsek rivers: one new site located (Line and Freese 2006).
- 2006-2008: Incidental discoveries of two new sites
- 2009: Detailed polygons delineated for a portion of Carcross dunes (Schroeder 2009).

[9] Habitat integrity can be more explicitly defined as the system’s capacity to sustain native biological and physical properties that have adapted to an area with natural events and processes (Wiken et al. 2003).

- 2009-2010: Canadian Wildlife Survey (CWS) focused surveys (some helicopter-based) from Whitehorse west to Dezadeash and Aishihik lakes, added seven new sites and improved knowledge of others (Line 2011, COSEWIC 2011).
- 2010: Parks Canada and others mapped Critical Habitat within Kluane National Park and Reserve
- 2011: CWS helicopter surveys targeting aeolian sand in Atlin and Tagish lake areas
- 2014: Incidental discovery of a small population on the west side of Bennett Lake
- 2015: Canadian Wildlife Service undertook initial mapping of proposed Critical Habitat in Carcross, Kusawa, Dezadeash, Champagne, and Taye Lake areas. Two new subpopulations were discovered and four new sites were added to known subpopulations.

Research:

- 2007: Parks Canada, Environment Yukon, and Canadian Museum of Nature began a population genetics study
- 2008-2009: Parks Canada and Environment Yukon began work with the University of Alaska to gain a better understanding of Baikal Sedge fruit viability. Further work on the smut fungus was carried out by Agriculture and Agri-Food Canada (J. Line, pers. comm. 2015).

Stewardship:

- 2008-2009: Initial work on invasive plant removal at Carcross dunes
- 2012: A federal Recovery Strategy led by Parks Canada was developed with the collaboration with First Nations, Canadian Wildlife Service, and Environment Yukon.
- 2012: Critical Habitat legally designated and protected in Kluane National Park and Reserve
- 2013: Carcross Local Area Plan (Yukon Government and Carcross/Tagish First Nation 2013) specifically mentions “protection of rare flora and fauna (e.g., Baikal Sedge)” as of “particular relevance to the planning process,” and labels much of the dune area “Environmental Protection.” This designation has not yet been officially zoned, however. Map 9 in the LAP document outlines the foreshore dunes along the shore of Lake Bennett and asks “how to protect rare plants?”
- 2015: Action Plan drafted
- 2015 and ongoing: The threat of White Sweet-clover moving down the Dezadeash River and impacting the Alsek Dunes has been managed actively by Parks Canada and the Village of Haines Junction.
- 2017: Parks Canada undertook an aerial survey to determine extent of flooding by Kaskawulsh River at the upper Alsek dunes
- 2021: The updated management plan for Kluane National Park and Reserve increased the protection of the lower Alsek dunes: access is only permitted for park operations or research. The upper Alsek dunes have been zoned as

Environmentally Sensitive Area which allows protection but also access that can enhance public awareness about dune complexes.

Outreach:

- 2007: Carcross-Tagish First Nations and Yukon Conservation Society (funded by the Habitat Stewardship Program) undertook community outreach walks and data collection through the summer.
- 2009-2010: Several First Nations received funding from the Aboriginal Fund for Species at Risk to collect traditional knowledge on Baikal Sedge and dune ecosystems, to perform some inventory work (see above), and to report back to the communities. In addition to adding new sites to the known distribution, this project resulted in increased awareness of the sedge in many local communities.
- 2012: Parks Canada developed brochure “Collaboration in Action” on working with First Nations to recover Baikal Sedge.
- 2017: Parks Canada worked with Champagne and Aishihik First Nation to highlight exercising caution when accessing the Alsek Dune area for harvesting (Parks Canada 2017).

6.2 Broad Strategies

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

1. Land management
2. Awareness raising
3. Conservation designation and planning
4. Research and monitoring

6.3 Conservation Measures

Table 3. Conservation Measures and Implementation Schedule. Broad Strategies taken from the Conservation Measures Partnership's (2016) Conservation Actions Classification v. 2.0.

Conservation Measure	Priority[e]	Threats or Concerns Addressed	Timeline
Broad Strategies			
Land management			
Management of recreational use of dunes: document impacts and determine management strategies where necessary; promote best practices at key sites	High	Recreational use of dunes; Threat 6	2023-2027
Monitor and manage/remove invasive species in Yukon dunes	High	Invasive species; Threat 8	Ongoing
Awareness raising			
Develop communication strategy; produce and distribute educational materials to the public, local and First Nations governments, private landowners, and other stakeholders	High	Recreational use; invasive species; Threats 6, 8	2023-2027
Conservation designation and planning			
Ensure that Baikal Sedge is considered in regional and local land use plansResearch and monitoring			
Map subpopulations and refine/continue counts	High	Knowledge gaps regarding distribution and trends	2023-2027, then ongoing
Research on rates and causes of dune stabilization	High	Fire suppression; other ecosystem modifications; climate change; Threats 7, 11	2023-2032
Continue research on the effect of smut fungus on the reproductive success of Baikal Sedge	Medium	Problematic native species; Threat 8	2023-2027
Continue genetic studies on the limited genetic variability within the Canadian population	Medium	Knowledge gaps; limiting factors	2023-2027

[e] *"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.*

6.4 Narrative to Support Conservation Measures and Implementation Schedule

Land management

Given the specialized and limited extent of the habitat needed by the Baikal Sedge, habitat management and stewardship are central to mitigating threats. Collaboration with governments, land owners, and industry is required to devise and implement strategies that would minimize habitat degradation. Restoring and enhancing habitat could offset the loss of habitats that are already irreparable. Follow up would be required for such strategies to determine whether they are working as intended or require further intervention.

Two of the primary threats to Baikal Sedge are dune stabilization and the overuse of all-terrain vehicles. Removal of exotic invasive species (with the support of government or non-government organizations) may help slow the stabilization of some of the dune complexes. Developing a strategy around all-terrain vehicle use in dunes will be useful in maintaining habitat integrity at some key sites.

Conservation designation and planning

Zoning and other land use planning measures (in regional or local plans) could regulate uses and allow for natural dune development in key areas.

Raising awareness

Public awareness (whether through signage, stakeholder engagement, educational materials, etc.) is key to a number of the foregoing strategies, especially around invasive plants, use of all-terrain vehicles, and the awareness of the unique nature of Yukon dunes. However, combining these efforts with those aimed at other dune specialist species (such as Dune Tachinid Fly) and general dune conservation likely would be more successful than focusing on a single species. In particular, meeting with organizations representing the recreational vehicle users would be valuable.

Research and monitoring

Baseline measurement of distribution and abundance is critical to monitoring progress. Mapping the detailed distribution of all occurrences of Baikal Sedge and making counts or more precise estimates of the numbers of ramets will document the overall trend of Baikal Sedge, and thus measure the success of other conservation measures. Most subpopulations probably are known; emphasis should be on monitoring those populations already identified. Precise mapping will aso be an opportunity to document the movement and development of the dunes as a whole, and measure the rate of dune stabilization.

Research on the effect of recreational vehicle use on habitat quality would be of value.

Little is known of the basic biology of the Baikal Sedge in Canada; research on the effects of the widespread smut fungus, lack of viable seed set, and potentially low genetic variability would allow better management decisions.

More detailed research may elucidate the various contributions of fire suppression, climate change, and spread of exotic plant species to dune stabilization. Research involving experimental prescribed fire and experimental removal of exotic plants would also inform management.

7. Measuring Progress

Five years after the publication of this management plan, the success of its implementation will be measured against the following performance indicators.

- Growth or lack of change in population size would indicate that the current extent of Baikal Sedge is increasing or stable. Declines would indicate that conservation actions are not effective in maintaining the population. Population trends will be determined by repeated surveys of Baikal Sedge at selected dune complexes.

- Reconnaissance surveys indicating consistent distribution of the Baikal Sedge in Canada (all known sites, and any additional sites discovered in the future) would indicate that the integrity of inhabited sites has been maintained.

- Where needed, explicit mitigation measures are developed and adopted that maintain habitat at sites occupied by Baikal Sedge. Monitoring surveys are in place to track the effectiveness of these mitigation measures, by measuring the disturbance (e.g. all-terrain vehicle use) at selected sites.

- Outreach products have been developed and distributed to governments and the public.

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Appendix A: Summary of Extant Baikal Sedge Populations in Canada

Updated from COSEWIC (2011) with data from Yukon Conservation Data Centre (2019).

LOCATION	ELEVATION (metres)	SITE	TOTAL COUNT
Alsek dunes, Kluane NPR	590	mix of stable and unstable dune habitat	2.5-3 million
Alsek Dune, lower, Kluane NPR	554	active sand dune of 53 hectares near Alsek River	2800
Takhini River, north of Kusawa Lake	665	complex of river blowout sand dunes in wilderness mountain park	app. 408,530-582,650
Carcross Dunes	660	Many dunes within a complex approximately 5 km^2 in extent	534,916-599,910
Robinson	760	small open patches of sand in open pine woodland	approx. 6000
Takhini River, 13.4 km NW of Kusawa Lake outlet	657	patch of lichen-covered sand along a river, surrounded by boreal forest	200
Riverdale	668-683	an active dune system on a variable slope	>49,530
Champagne, 2.5 km-5.5 km NW of	648	a chain of hillside blowout sand patches that face SW over the Dezadeash River	112,000 - 113,000

LOCATION	ELEVATION (metres)	SITE	TOTAL COUNT
Champagne, 1.4 km NE ("Champagne 3")	732	a south-facing blowout with active undulating sand	5000-6000
Dezadeash Lake, north end	845	open shrubby south-facing boreal and subalpine slope interrupted by terraces of slightly concave sand dune pockets at the north end of a large lake	12,700
Taye Lake, 6 km SW of	1153-1235	a mosaic of concave sand dune 'bowls'at high elevation	2010: 25,000; 2017: 100-200
Dezadeash Lake, north end, 4 km NW of	1173-1196	an open, treed and shrubby SW facing subalpine slope interrupted by terraces of slightly concave sand dune pockets at the north en of a large lake	27,000
Shaneinbaw Lake, 3 km SE of	1138-1267	dune and sand blowout complex in subalpine woodland on a south-facing mountain slope	approx. 58,400
Rose Creek	1075-1105	dune complex in rolling terrain with minimal slope and in a remote mountainous setting	28,000-30,000
Shaneinbaw Lake, 4.3 km NE of	860	a series of small sand dune/blowouts amidst largely forested dunes in a mountain valley	2925
Taye Lake, 3 km SW of	1178	2 sand blowouts in dry subalpine forest	700
		TOTALS	**3,369,885 to 4,517,015**

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.

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

This management plan will clearly benefit the environment by promoting the conservation of the Baikal Sedge and its rare dune habitat; and at some sites, the listed Dune Tachinid Fly.

The potential for the plan to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this plan 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: description of the species' habitat and biological needs, ecological role, and limiting factors; effects on other species; and the implementation actions.

[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/