COSEWIC
Assessment and Status Report

on the

Baikal Sedge
Carex sabulosa

in Canada

SPECIAL CONCERN
2016

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

COSEWIC. 2016. COSEWIC assessment and status report on the Baikal Sedge *Carex sabulosa* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xii + 43 pp. (http://www.registrelep-sararegistry.gc.ca/default_e.cfm).

Previous report(s):

COSEWIC 2005. COSEWIC assessment and status report on the baikal sedge *Carex sabulosa* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. İx + 22 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Production note:
COSEWIC acknowledges Syd Cannings for writing the status report on the Baikal Sedge, *Carex sabulosa*, in Canada, prepared with the financial support of Environment Canada. This report was overseen and edited by Del Meidinger, Co-chair of the COSEWIC Vascular Plants Specialist Subcommittee.

For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: 819-938-4125
Fax: 819-938-3984
E-mail: ec.cosepac-cosewic.ec@canada.ca
http://www.cosewic.gc.ca

Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur le Carex des sables (*Carex sabulosa*) au Canada.

Cover illustration/photo:
Baikal Sedge with fruiting heads, Lower Alsek River Dunes, Kluane National Park and Reserve. Photo by Jennifer Line, with permission.

Catalogue No. CW69-14/429-2016E-PDF
ISBN 978-0-660-05763-7

COSEWIC
Assessment Summary

Assessment Summary – May 2016

Common name
Baikal Sedge

Scientific name
Carex sabulosa

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.

Occurrence
Yukon

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

COSEWIC
Executive Summary

Baikal Sedge
Carex sabulosa

Wildlife Species Description and Significance

The Baikal Sedge, *Carex sabulosa*, is a tufted perennial plant with long rhizomes. As the flowers mature, the slim stems arch and droop, and the heavy fruiting heads sometimes touch the ground.

Baikal Sedge occurs in a dune ecosystem that was once widespread but is no longer common in Canada; the potential sites for the plant are restricted. In addition, the subpopulations are of probable genetic interest because they are disjunct from, and at the eastern periphery of, a fragmented range that extends from central Asia to southwestern Yukon. Baikal Sedge is an important species in the stabilization of dunes.

Distribution

Baikal Sedge is found in the sands of central Asia, from Kazakhstan through southern Siberia and western China to Mongolia. Over 3000 km away in North America, it occurs in one dune field in west-central Alaska and in 10 dune fields (16 subpopulations) in a small region of the southwestern Yukon. Two additional occurrences have not been relocated, despite searches, and are considered extirpated.

Habitat

Baikal Sedge occurs on the accumulating surfaces of active and semi-stabilized dunes, where it is often the only prominent vascular plant species. In the Yukon, these dunes are remnants of much larger dune fields that were present at the end of the Pleistocene. Most of the ancient dunes are now stabilized and covered in forest or grassland. Many of the extant Baikal Sedge sites are limited to small blowouts in dunes without large supplies of open sand.

Biology

The biology of Baikal Sedge has not been studied. It is evident, however, that this species can withstand cold, desiccating winds and accumulating sand. Reproduction is primarily vegetative through rhizomes; seed production is often limited. In the Yukon, a smut fungus, *Planetella lironis*, attacks developing fruits (seed-like achenes); the smut's effect on reproductive success remains unknown.

Population Sizes and Trends

The largest subpopulation is found near the confluence of the Kaskawulsh and Dezadeash rivers in Kluane National Park and Reserve. There are an estimated 2.5 to 3 million ramets (tufts) at this site. The remaining 15 subpopulations have an estimated total of 1,053,000 ramets, giving an estimated Canadian population of roughly 3.5 to 4 million ramets.

Population trends at all but the Carcross dune systems have probably remained roughly stable in recent years, although there has probably been a small decline because of natural succession and dune stabilization. Baikal Sedge has probably declined more substantially at the Carcross dunes; a decline based both on an apparent reduction in active dunes and on an apparent decrease in sedge extent on active dunes.

Threats and Limiting Factors

Natural vegetation succession is a limiting factor to Baikal Sedge persistence, through dune stabilization. This process is of concern at the largest (Alsek) subpopulation at the confluence of the Kaskawulsh and Dezadeash rivers. Fire suppression allows for more rapid vegetation succession and this threatens several of the subpopulations. There is an apparent loss of dune habitat as a result of stabilization at Carcross as well. Invasive plants that accelerate dune stabilization pose a significant future threat.

The threat of disturbance from off-road recreational vehicles is of most concern at the Carcross dunes, but also to a lesser extent at the Takhini River (south) dune system. Excessive off-road vehicle use not only damages the plants at the surface, but also compacts the sand and eliminates the clones.

Development of dunes for residential lots or tourism operations is of concern behind the Bennett Lake beach at Carcross.

Protection, Status and Ranks

Baikal Sedge is listed as Threatened under the federal *Species at Risk Act* in Canada. Critical Habitat has only been identified within Kluane National Park and Reserve, where it also receives some measure of protection under the *Canada National Parks Act*. The Takhini River dune system is protected from development in the as-yet-undesignated Kusawa Territorial Park; a draft management plan has recently been developed for this park. The subpopulations northeast of the Klondike Highway at Carcross occur within a territorial park reserve; however, off-road vehicles use this site regularly, and this activity continues to reduce the area of occupancy of the sedge. Recovery at this site is not possible given the current level of use. Elsewhere, Baikal Sedge occurs on Crown (Commissioner's) land where only a special federal order can protect the species under the *Species at Risk Act*. In the NatureServe ranking system, it is ranked G5 (Secure) globally, N2 (Imperilled) nationally and S2 in Yukon.

TECHNICAL SUMMARY

Carex sabulosa

Baikal Sedge

Carex des sables

Range of occurrence in Canada (province/territory/ocean): Yukon

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	5-7 years; rough estimate; clones can live for a very long time but individual ramets much less, perhaps 12 years.
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes Observed, inferred and projected
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Small, but certainly < 5%
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Observed, small decline; certainly < 10%
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Small reduction; certainly < 10%
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Observed and suspected, small reduction; certainly < 10%
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. perhaps reversible, except for natural succession which is likely the greatest long-term threat. b. understood c. not ceased
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	7860 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	134 km²

Is the population "severely fragmented" ie. is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. probably not b. yes
Number of "locations"* (use plausible range to reflect uncertainty if appropriate)	13-18
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Yes Apparent loss of Christmas Bay and Kusawa Lake W subpopulations have reduced the EOO; it is unknown when this occurred.
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Yes Loss of at least two subpopulations; timing unknown
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Yes Loss of at least two subpopulations; timing unknown
Is there an [observed, inferred, or projected] decline in number of "locations"*?	Yes, observed decline, based on loss of at least two subpopulations; timing unknown
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes Observed and projected
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of "locations"*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals (in this case ramets, many of which are probably not genetically distinct individuals)**
Alsek (Kaskawulsh-Dezadeash confluence)	2,500,000 – 3,000,000
Lower Alsek	2800
Carcross	603,910+ (may be as high as 1,000,000)
Robinson	6000
Takhini 1	535,000
Takhini 2	200

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Dezadeash Lake, N end	13,000
Dezadeash Lake, 4.5 km N	15,000
Rose Creek	30,000
Champagne 1&2	113,000
Champagne 3	6000
Taye Lake 1	25,000
Taye Lake 2	1000
Taye Lake 3	700
Taye Lake west	58,000
Whitehorse (Riverdale)	49,000
Total	3,958,610 – 4,458,610

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not done.

Threats (actual or imminent, to populations or habitats, from highest impact to least)

i. Invasion of exotic and other problematic species, resulting in competition and dune stabilization
ii. Habitat degradation by increasing use of off-road vehicles
iii. Residential and commercial development in the Carcross area
iv. Fire suppression, aiding dune stabilization
v. Transportation corridors: development of second access road in Carcross

Was a threats calculator completed for this species and if so, by whom? Yes, 14 January 2016, participants were Syd Cannings, Dwayne Lepitzki, Del Meidinger, Bruce Bennett, Tom Jung, Todd Powell, Saleem Dar, Pippa Sheppard, Nathalie Leclerc, Phil Emerson, John Miekle, Jim Pojar, Eric Lamb, Andy MacKinnon, Michael Jim, Karen Timm.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Ranked S1 in Alaska. Only Alaska population is at the Nogahabara Dunes, Kobuk National Wildlife Refuge.
Is immigration known or possible?	Not likely, given 1130 km distance without intervening appropriate habitat.
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	No, habitat is limited. Some unoccupied dunes exist, but these are very small and not as active as preferred by Baikal Sedge
Are conditions deteriorating in Canada?[+]	Yes

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Are conditions for the source population deteriorating?[+]	Unknown
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species? No

Status History

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

Status and Reasons for Designation:

Status: Special Concern	**Alpha-numeric codes:** Not applicable
Reasons 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.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Decline thresholds not met.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Meets TH B1 and EN B2 for size of EOO and IAO, respectively, with an inferred decline in IAO and observed and projected decline in the amount and quality of habitat. However, there are more than 10 locations and the species is not severely fragmented; nor does it exhibit extreme fluctuations.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Although number of mature individuals is unknown, the total will exceed thresholds.
Criterion D (Very Small or Restricted Population): Not applicable. The population is not very small nor restricted.
Criterion E (Quantitative Analysis): Not applicable. Lack population data to conduct analysis.

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect)

PREFACE

In the decade since the Baikal Sedge was assessed as Threatened in 2005, much searching both focused and incidental, has resulted in a considerable increase in knowledge of this species in Canada, and has increased the number of known subpopulations from 5 to 16.

In 2006, a Parks Canada-NatureServe Yukon survey along the Slims, Kaskawulsh, Dezadeash, and Alsek rivers resulted in the discovery of a new site on the Alsek River, 18 km downstream of the known site at the Alsek dunes (Line and Freese 2006). Incidental discoveries of two new sites (Robinson and Whitehorse [Riverdale]) were made in 2006 and 2008, respectively. In 2009 and 2010, using information coming from interviews in First Nations communities and from satellite imagery, focused surveys (including several helicopter-assisted surveys) were made throughout the area bounded by Whitehorse, Aishihik Lake, Dezadeash Lake, and Kusawa Lake (Line 2011). As part of this work, detailed Baikal Sedge polygons were delineated for a portion of the Carcross dunes (Schroeder 2009). Surveys in 2009 designed to gather information for the Dune Tachinid Fly (*Germaria angustata*) COSEWIC report also added to the search effort (COSEWIC 2011). These two seasons added one subpopulation at Dezadeash Lake, two near Taye Lake, three adjacent to the hamlet of Champagne, one along Rose Creek, and expanded our knowledge of the subpopulations along the Takhini River and at Robinson. In 2011, helicopter-assisted surveys by Environment Canada staff targeted sandy areas associated with Atlin and Tagish lakes in northern British Columbia, but they were unsuccessful in locating new sites. In 2014, an incidental discovery was made of a small population on the west side of Bennett Lake, near the Carcross dunes. These surveys resulted in an increase in the extent of occurrence from 2560 km^2 to 7860 km^2.

In 2007, Parks Canada, the Yukon government and the Canadian Museum of Nature began a population genetics study, the purpose of which is to determine the levels of genetic diversity at each site, compare diversity among the sites, and to shed some light on the amount of cloning within each population.

Also in 2007, the Yukon government, in partnership with the Carcross/Tagish First Nation and the Yukon Conservation Society, received funding from the federal Habitat Stewardship Program to begin community outreach and data collection for recovery planning. Interpretive hikes were held throughout the summer.

In 2008 and 2009, Parks Canada and the Yukon government 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. Some initial work on invasive species removal was carried out in the Carcross dunes. Analyses of these data are ongoing.

Several First Nations in southern Yukon received funding from the Aboriginal Funds for Species at Risk in 2009 and 2010 to collect traditional knowledge on Baikal Sedge and sand 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.

In 2010, Parks Canada worked with First Nations and the Yukon government to map and assess the density and health status of Baikal sedge in the Alsek Dunes and the Lower Alsek Dunes for the purposes of identifying critical habitat.

A federal Recovery Strategy, led by Parks Canada, was developed with the participation of the First Nations within the sedge's range, as well as federal and territorial agencies and regional non-government organizations. The strategy was posted in 2012, and an action plan was drafted in 2015.

In 2015, while working on Critical Habitat mapping, Environment Canada staff made additional visits to the Dezadeash Lake, Champagne, and Taye Lake areas. They discovered two new subpopulations west of Taye Lake and added four new sites to known subpopulations in the Dezadeash and Taye Lake areas.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2016)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment and Climate Change Canada
Canadian Wildlife Service

Environnement et Changement climatique Canada
Service canadien de la faune

Canada

The Canadian Wildlife Service, Environment and Climate Change Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Baikal Sedge
Carex sabulosa

in Canada

2016

TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Major plant group: Monocot flowering plant

Family: Cyperaceae (Sedge Family)

Scientific name: *Carex sabulosa* Turczaninow ex Kunth

Synonyms: *Carex leiophylla* Mackenzie
Carex sabulosa ssp. *leiophylla* (Mackenzie) A.E. Porsild

English names: Baikal Sedge, Sand Sedge

French name: Carex des sables

Carex sabulosa was first described in 1837 from material collected in central Asia near Lake Baikal. In North America, Baikal Sedge was first recognized as *C. leiophylla* (Murray 2002). Later, the species was considered synonymous with *C. sabulosa* by Raymond (1965). Porsild (1966) published the combination *Carex sabulosa* ssp. *leiophylla* (Mackenzie) A.E. Porsild, based on minor differences between the Asian and North American plants. Murray (2002) placed ssp. *leiophylla* in synonymy with *C. sabulosa* because the North American material falls "well within the variability of *C. sabulosa* from Asia."

Morphological Description

Baikal Sedge is a tufted perennial with long rhizomes (Cody 2000). It has a long, thin triangular stem that can be between 15 and 35 cm long. The 1-3.5 mm-wide, grass-like leaves are thick at the base, greyish-green, flat with involute margins and taper to a fine tip. The leaves have long, usually underground, reddish or purplish sheaths, and are mostly shorter than the stems. Old, dry basal leaves are usually curled and persistent (Figure 1). As the flowers mature, the stems become weighed down by the drooping fruiting heads and take on a characteristic arched appearance.

Small clusters of cream-coloured flowers grow on three to five spikes that emerge from the top few centimetres of the stem. The club-shaped terminal spike often has female flowers positioned above the male flowers while the remaining lateral spikes have only female flowers (Ball and Reznicek 2002). The lateral spikes may be aggregated or the lower ones may be separated.

Baikal Sedge is distinguished from other sedges in Yukon by the presence of at least some lateral spikes with stalks; glabrous, spreading to ascending perigynia which have toothed beaks; lack of septate-nodulose leaf sheaths (Welsh 1974); long, mostly underground, reddish leaf sheaths; and usually curled basal leaves.

Figure 1. Young Baikal Sedge flowers; the female flowers are surrounded by dark brown scales at this age. Curly leaves from last year's growth are visible. Takhini River, 27 May 2007. Photo: Jennifer Line. Inset: Developing fruit, showing balloon-like structures covering the developing seeds. Lower Alsek River dune, 19 July 2007. Photo: Jennifer Line; used with permission.

Population Spatial Structure and Variability

Initial results from a population genetics study indicate that there is limited genetic variation within the Canadian population, which may be a result of cloning (Saarela pers. comm., cited in Baikal Sedge Recovery Team 2012), but could be related to small population size, founder effects, or other factors. Additional work must be done in order to verify these findings.

The Canadian population of Baikal Sedge is separated by over 1,100 km from the only other North America occurrence at Nogahabara Sand Dunes, Alaska and more than 2,000 km from sites in Russia. This distance may have created genetic structure or strong demographic isolation within the Canadian part of the range, as well as between Canadian subpopulations and those outside Canada. Morphological and genetic variability has not been investigated between Canadian subpopulations and those in the US or Asia.

Designatable Units

The few subpopulations in Canada occur in a small area of one ecozone and are probably remnants of a single, larger population; they are thus considered to be one designatable unit.

Special Significance

Baikal Sedge occurs with a number of other northern dune specialist species in an ecosystem that, over the course of the Holocene, has shrunk considerably in size and is now rare on the landscape. Baikal Sedge is an important species in the stabilization of dunes.

In addition, the Canadian subpopulations may be of genetic interest because they are disjunct from and at the eastern edge of a range that extends from central Asia to the southwestern Yukon. Disjunct and edge of range populations are often genetically and morphologically divergent from central populations and may have evolutionary and ecological significance (Mayr 1982; Lesica and Allendorf 1995). The protection of genetically distinct peripheral populations may be important for the long-term survival of the species as a whole (Lesica and Allendorf 1995).

DISTRIBUTION

Global Range

Found in two widely separate areas: central Asia (Kazakhstan, Russia [southern Siberia], Mongolia, and western China [Xinjiang]) 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 2016). The only Alaska locality is the Nogahabara Dunes, which are about 1100 km northwest of the Canadian range (Alaska Natural Heritage Program 2014).

Canadian Range

In Canada, the Baikal Sedge is restricted to sixteen sites in ten active dune fields in the southwestern Yukon, from Kluane National Park Reserve west to Whitehorse, and south to Dezadeash Lake and Carcross (Table 1, Figure 2, Baikal Sedge Recovery Team 2012; Yukon Conservation Data Centre 2016). Many if not most of the dunes are associated with significant sand deposits laid down as the last Pleistocene 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 the fields are even more restricted because most of the dunes are now forested.

Table 1. Known sites of Baikal Sedge in Canada. Areas and population estimates are taken from occurrence records in Yukon Conservation Data Centre (2016). (NOTE latitude and longitude information has been removed from this report and is on file with COSEWIC Secretariat.)

First Nations ownership; CTFN = Carcross-Tagish First Nation; CAFN = Champagne and Aishihik First Nations; KDFN = Kwanlin Dun First Nation; WP&YR = White Pass and Yukon Route

Locality or Subpopulation	Elevation (m)	Ownership	Approx. area (ha)	Estimated no. of ramets
Carcross	665	Crown, CTFN, WP&YR	46	603,910+
Robinson	755	Crown, WP&YR	2	6000
Takhini River 1	680	Crown, KDFN	30	535,000
Takhini River 2	657	Crown, KDFN	0.5	200
“Alsek” (Dezadeash-Kaskawulsh)	590	Parks Canada	50	2.5-3 million
Lower Alsek		Parks Canada	0.2	2800
Dezadeash Lake N end	842	Crown	5	12,700
Dezadeash Lake, 4.5 km N	1185	Crown	1	27,000
Rose Creek	1075	Crown	2	30,000
Champagne 1&2	648	CAFN, Crown	1.6	113,000
Champagne 3	732	CAFN	0.14	6000
Taye Lake complex	1153	Crown	1.4	25,000
Taye Lake complex 2	1054	Crown	TBD	1000
Taye Lake complex 3	1177	Crown	TBD	700
Taye Lake W	1138	Crown	1.6	69,000
Whitehorse, Riverdale	680	Crown	0.11	49,000
Total				**3,958,610 – 4,458,610**

Two more sites remain unconfirmed but are likely extirpated; these are represented by orange circles in Figure 2. One is represented by a collection taken at Christmas Bay, Kluane Lake in 1974. The entire windward area at the latter site, covering an area of about 30 to 40 m wide and 2 km long, was searched in 2003 and again in 2006 without positive results (COSEWIC 2005; Line and Freese 2006). Another is represented by a collection near Kusawa Lake in 1986. This site was not known to the writers of the 2005 COSEWIC status report; it is now deduced to be in beach dunes at the north end of a small lake on the west side of Kusawa Lake (Yukon Conservation Data Centre 2016). These dunes, which appeared to have stabilized and vegetated considerably in the last quarter century, were searched in 2009 but no Baikal Sedge was found (Yukon Conservation Data Centre 2016).

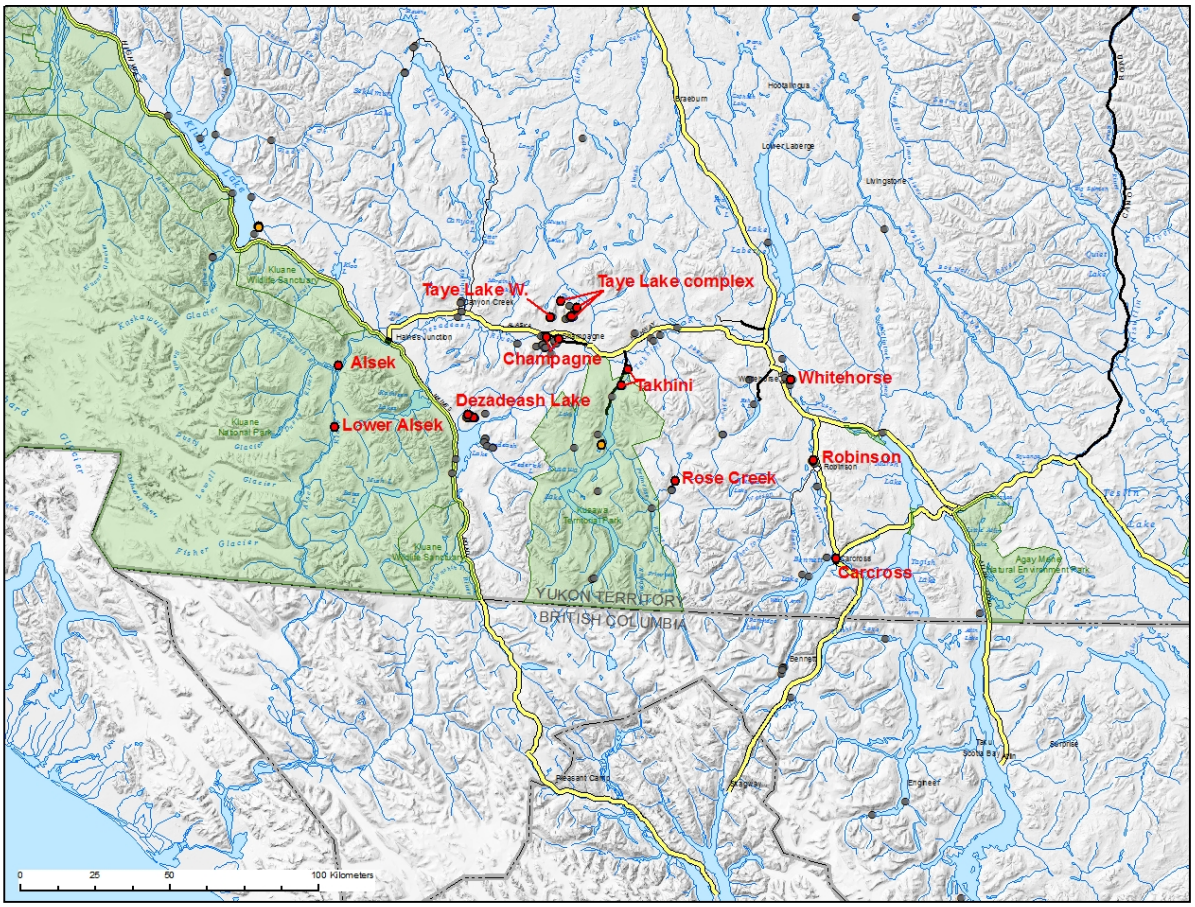

Figure 2. Known occurrences of and targeted search effort for Baikal Sedge in southwestern Yukon. Red dots: known occurrences. Orange dots: historical occurrences, presumed extirpated. Grey dots: sites searched where no Baikal Sedge was found.

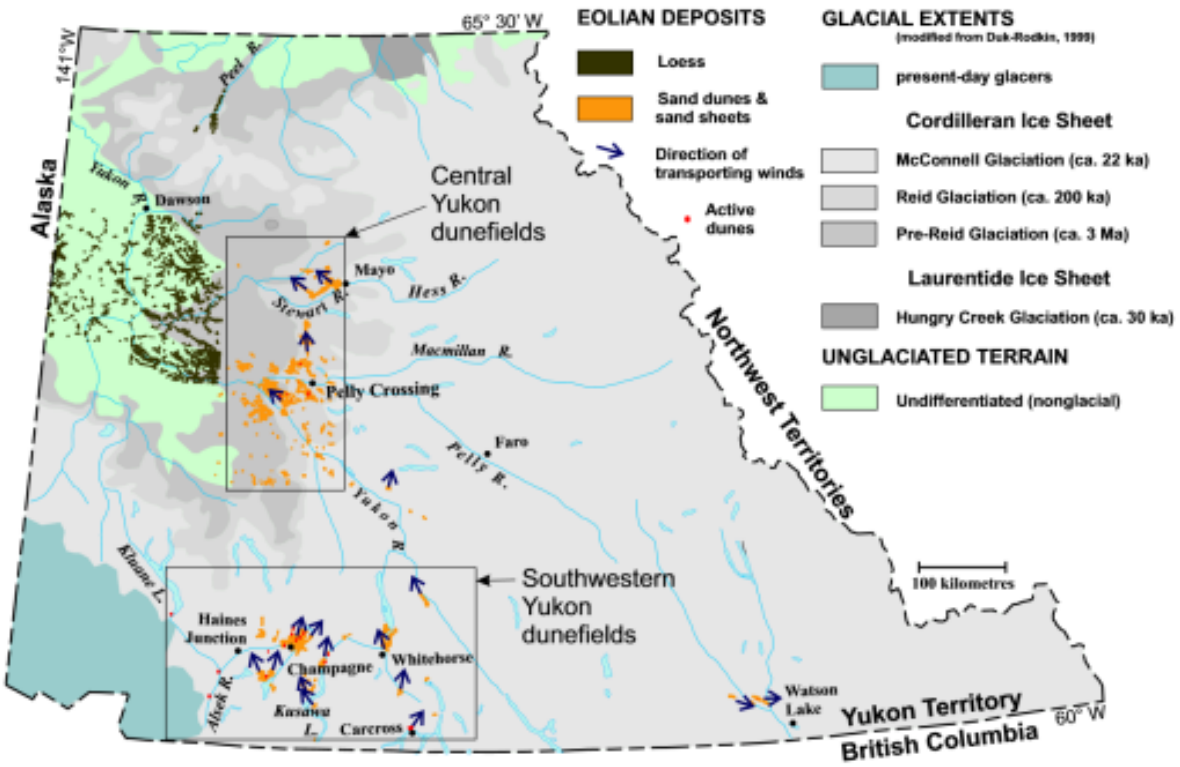

Figure 3. Aeolian deposits of southwestern Yukon. Vegetated, stabilized dunes in orange; active dunes in red; direction of transporting winds marked by arrows. All Canadian occurrences of Baikal Sedge are within the southern rectangle. There are few, if any active dunes in the Central Yukon dune fields. Courtesy of Stephen Wolfe, Geological Survey of Canada, Ottawa.

Extent of Occurrence and Area of Occupancy

The calculated extent of occurrence—a polygon drawn around the known, extant records—is 7860 km^2. This is an increase of 5300 km^2 compared to the value in the 2005 report, which was recalculated to be 2560 km^2 based on extant populations. This increase is solely the result of increased search effort. If the historical occurrence at Kluane Lake is added to the current EOO, it would be 10,188 km^2. The index of area of occupancy (the number of 2 km by 2 km map grid cells occupied) is 134 km^2; this is an increase of 86 km^2 from the value in the 2005 report, which was recalculated to be 48 km^2. Although most of the active dune systems in southwestern Yukon have been searched for Baikal Sedge, there are a few small ones that remain unsurveyed. Thus, there is a possibility that the IAO may increase by a relatively small amount.

Search Effort

Since 2005, many surveys, both focused and incidental, have been undertaken (Tables 2 and 3). In 2006, a Parks Canada-NatureServe Yukon survey searched the valleys of the Slims, Kaskawulsh, Dezadeash, and Alsek rivers (Line and Freese 2006). Incidental discoveries of two new sites (Robinson and Whitehorse [Riverdale]) were made in 2006 and 2008, respectively. An isolated patch of Baikal Sedge across the Watson River from the main Carcross dunes was also found incidentally in 2014 (Stotyn pers. comm. 2014). In 2009 and 2010, using information coming from interviews in First Nations communities and from satellite imagery, focused surveys (including several helicopter-assisted surveys) were made throughout the area bounded by Whitehorse, Aishihik Lake, Dezadeash Lake, and Kusawa Lake (Line 2011). Surveys in 2009 designed to gather information for the Dune Tachinid Fly (*Germaria angustata)* COSEWIC report also added to the search effort (COSEWIC 2011). In 2011, helicopter-assisted surveys by Environment Canada staff targeted sandy areas associated with Atlin and Tagish lakes in northern British Columbia.

Fewer than five small, difficult-to-access dune fields remain that have yet to be properly surveyed for Baikal Sedge: the south-facing slopes along the Kluhini River draining Frederick Lake and the dunes across the Dezadeash River from Champagne have been visited briefly without success. However, both of these areas are characterized by many, small blowouts, similar to those at the Dezadeash Lake and Taye Lake areas; they will not contain major subpopulations. Other dune fields northwest of and south of Watson Lake, Yukon have not been visited, but these are small and may be too isolated from the centre of the distribution in southwestern Yukon to be likely candidates. Dune fields in the central Yukon (Figure 3) are largely forested now; no active dunes of even modest size can be found on satellite imagery.

Table 2. Surveying effort for Baikal Sedge in Kluane National Park and Reserve in 2006 Adapted from Appendix II in Line and Freese (2006).

Date	Locality	Surveyors	Time searching	Comments
4 Jul	Alsek dunes	J. Line (JL), L. Freese (LF)	3 hrs	Found Baikal Sedge; no smut observed
5-8 Jul	Kaskawulsh River	JL, LF, S. Stewart, L. Gorecki	3 days on river, 2 hrs searching on land	No Baikal Sedge. Dunes with shallow sand. Associated plants at known population present.
9 Jul	Alsek dunes	JL, LF, L. Schroeder	3 hrs	Mapped Baikal Sedge in stable, SE lobe of dune. No smut observed
19 Jul	Slims River east	JL, LF, D. Smeeton	8 hrs	No Baikal Sedge found.
24 Jul	Slims River west	JL, LF, K. MacLaughlin	8 hrs	No Baikal Sedge found in large dune complex.
31 Jul-5 Aug	Alsek River, rafting from Haines Junction to Plug Creek	LF, unnamed others	5 days on river, 3-5 hrs searching on land	No Baikal Sedge found

Date	Locality	Surveyors	Time searching	Comments
12-15 Aug	Alsek River, rafting from Serpentine Cr to Marble campsite	JL, M. Riseborough, unnamed others	3 days on river, 4-6 hrs searching on land	Baikal Sedge found on dune complex east of Waterfall Cr.
16 Aug	Alsek dunes	JL, LF	5 hrs	Mapped Baikal Sedge in unstable NW lobe of dune. Smut observed on many plants
17 Aug	Dezadeash River	JL, LF	6 hrs on river, 1 hr searching on land	No Baikal Sedge found.
18 Sep	Alsek River, downstream of lower populations, by helicopter	JL, LF, A. Chilibeck	2 hrs	No new Baikal Sedge populations found.

Table 3. Search effort for new Baikal Sedge sites, 2009-2015. Sites are in Yukon unless otherwise noted. (NOTE latitude and longitude information has been removed from this report and is on file with COSEWIC Secretariat.)

Site	Elev. (m)	Date	Baikal Sedge	Surveyor(s)
Aishihik L., 12 km W	1220	13-Jul-09	NO	S. Cannings, J. Line, C. Kennedy
Atlin L., Llewellyn Glacier, BC	675	9-Sep-11	NO	S. Cannings
Atlin L., BC, N end	664	16-Sep-11	NO	S. Stotyn
Bennett, BC, 0.45 km SW	690	22-Jun-09	NO	L. Mennell
Bennett, BC, 0.5 km SW	690	22-Jun-09	NO	L. Mennell
Bennett, BC, 1.0 km SW	715	21-Jun-09	NO	L. Mennell
Bennett, BC, 1.0 km SW	715	22-Jun-09	NO	L. Mennell
Bennett L., Millhaven Bay	667	13-Sep-11	NO	L. Mennell
Bennett L., W of Watson R.	670	27-Jul-09	NO	L. Mennell
Bennett L. W of Watson R.	670	18-Apr-14	YES	S. Stotyn
Bennett L. W of Watson R.	670	27-Apr-14	YES	S. Stotyn, S. Dar
Bennett L., Wheaton R.	646	13-Sep-11	NO	S. Stotyn
Canyon, 3 km SW	670	13-Jul-09	NO	S. Cannings, L. Mennell
Champagne, 1.4 km NE	730	23-Jul-09	YES	L. Mennell, L. Schroeder
Champagne, 1.6 km NE	730	23-Jul-09	NO	L. Mennell, L. Schroeder
Champagne, Dezadeash R.	700	20-Jul-09	NO	L. Mennell
Champagne, 2.5 km SW	720	8-Jul-15	NO	L. Mennell, S. Cannings
Chilkoot Trail, Two Pond boardwalk	715	21-Jun-09	NO	L. Mennell
Christmas Bay, N side	825	7-Jun-13	NO	S. Cannings, S. Dar, S. Stotyn

Site	Elev. (m)	Date	Baikal Sedge	Surveyor(s)
Dezadeash Lake, 2 km N	880	13-Jul-09	YES	S. Cannings, J. Line, C. Kennedy
Dezadeash Lake, 2.5 km N	800	9-Jul-15	NO	L. Mennell, S. Cannings
Dezadeash Lake, 4.9 km N	1130	9-Jul-15	YES	L. Mennell, S. Cannings
Dezadeash Lake, 5.5 km N	1116	9-Jul-15	YES	L. Mennell, S. Cannings
Dezadeash R., 0.7 km NW of Champagne	700	8-Jul-09	NO	S. Cannings, L. Mennell
Dezadeash R., 2.6 km NW of Champagne	700	9-Jul-09	YES	L. Mennell
Dezadeash R., 3.7 km NW of Champagne	700	9-Jul-09	YES	L. Mennell
Dezadeash R., 5.3 km NW of Champagne	700	8-Jul-09	YES	S. Cannings, L. Mennell
Fantail Lake, BC	650	16-Sep-11	NO	S. Stotyn
Fox Creek, Lake Laberge	635	3-Jun-09	NO	S. Cannings
Gladstone Cr.	1095	5-Jun-13	NO	S. Cannings, S. Stotyn, S. Dar
JoJo Lake, N of	906	13-Sep-11	NO	S. Stotyn
JoJo Lake, NE of	1190	13-Sep-11	NO	S. Stotyn
Kluane L., Cultus Bay	820	5-Jun-13	NO	S. Cannings, S. Stotyn, S. Dar
Kluane L., N of Gladstone Cr.	817	5-Jun-13	NO	S. Cannings, S. Stotyn, S. Dar
Kluhini Cr., 1.3 km NE	823	9-Jul-15	NO	L. Mennell, S. Cannings
Kusawa L., NE of	1237	13-Sep-11	NO	S. Stotyn
Kusawa Territorial Park, “Ten-Mile” Lake	810	6-Jul-09	NO	L. Mennell
Lewes Lake	715	13-Sep-11	NO	S. Stotyn
Lindeman L., N end, BC	680	21-Jun-09	NO	L. Mennell
Rose Creek	1040	20-Aug-10	YES	J. Line, J. Meikle
Maud L., BC	843	13-Sep-11	NO	S. Stotyn
Sekulmun L., N end	900	13-Jul-09	NO	S. Cannings
Shaneinbaw L., 3 km SW	1150	8-Jul-15	NO	L. Mennell, S. Cannings
Slims R., S of Bullion Cr.	840	3-Jul-09	NO	S. Cannings, L. Mennell
Slims R., S of Bullion Cr.	830	3-Jul-09	NO	S. Cannings, L. Mennell
Stony Creek	860	28-Jul-09	NO	S. Cannings
Tagish L., Ben My Chree, BC	661	16-Sep-11	NO	S. Stotyn

Site	Elev. (m)	Date	Baikal Sedge	Surveyor(s)
Takhini R. bridge, Alaska Hwy.	660	19-Jun-09	NO	S. Cannings
Takhini R., 10 km ENE of Mendenhall Landing	660	30-Jul-09	NO	S. Cannings
Takhini R., 10.6 km. NE Mendenhall Landing	660	13-Jun-09	NO	K. Halliday
Takhini R., 13.3 km ENE of Mendenhall Landing	660	30-Jul-09	NO	S. Cannings
Taye L., 3 km SW	1170	8-Jul-15	YES	L. Mennell, S. Cannings
Taye L.. 5.3km SW	850	8-Jul-15	YES	L. Mennell, S. Cannings
Taye L., 6 km SW	1200	13-Jul-09	YES	S. Cannings, J. Line, C. Kennedy
Taye L., 11 km SW	1220	8-Jul-15	YES	L. Mennell, S. Cannings
Taye L., 12.5 km SW	1245	2-Aug-10	YES	J. Line, L. Mennell
Tutshi L., BC	705	16-Sep-11	NO	S. Stotyn
Wann River, BC	653	16-Sep-11	NO	S. Stotyn
Whitehorse, bluffs N of airport	695	2-Jul-09	NO	S. Cannings, L. Mennell
Whitehorse, 5 km N	650	11-Jul-08	NO	S. Cannings
Whitehorse, S end of airport	690	30-Jun-09	NO	S. Cannings, L. Mennell
Whitehorse, N end of airport	690	2-Jul-09	NO	S. Cannings, L. Mennell
Whitehorse, Riverdale, “Vee”	680	15-Jun-09	YES	S. Cannings, L. Mennell
Whitehorse, Riverdale, Grey Mtn. Rd.	690	14-Jul-08	NO	L. Randall, S. Cannings
Whitehorse, Schwatka L., N end	680	12-Jul-08	NO	S. Cannings

HABITAT

Habitat Requirements

Baikal Sedge occurs as a dominant species only on the accumulating surfaces of active dunes (Figure 4). Although these rhizomatous plants have the ability to send up new ramets when older ones have been completely buried, sand deposits greater than 1 m in depth that occur over short periods appear to restrict the growth of ramets (COSEWIC 2005). As dunes become stabilized, Baikal Sedge will persist until outcompeted or shaded by invading plants.

Dunes are maintained by a constant source of open sand and consistent winds. At Carcross, the source is abundant beach sand at the north end of Bennett Lake, and the lake is oriented so that the strong, prevailing southerly winds hit the beach almost squarely (Figure 5). At the Takhini River sites, the river runs through deposits that are either wholly sand or are capped by thick sand deposits. These deposits are kept open through constant erosion from the river, and are blown into dunes where the river runs at right angles to the prevailing wind (Figure 6).

Figure 4. Small dune field along Rose Creek. Prevailing winds run from lower right to upper left. Baikal Sedge sites (areas of sand accumulation) outlined in yellow. Photo: John Meikle; used with permission.

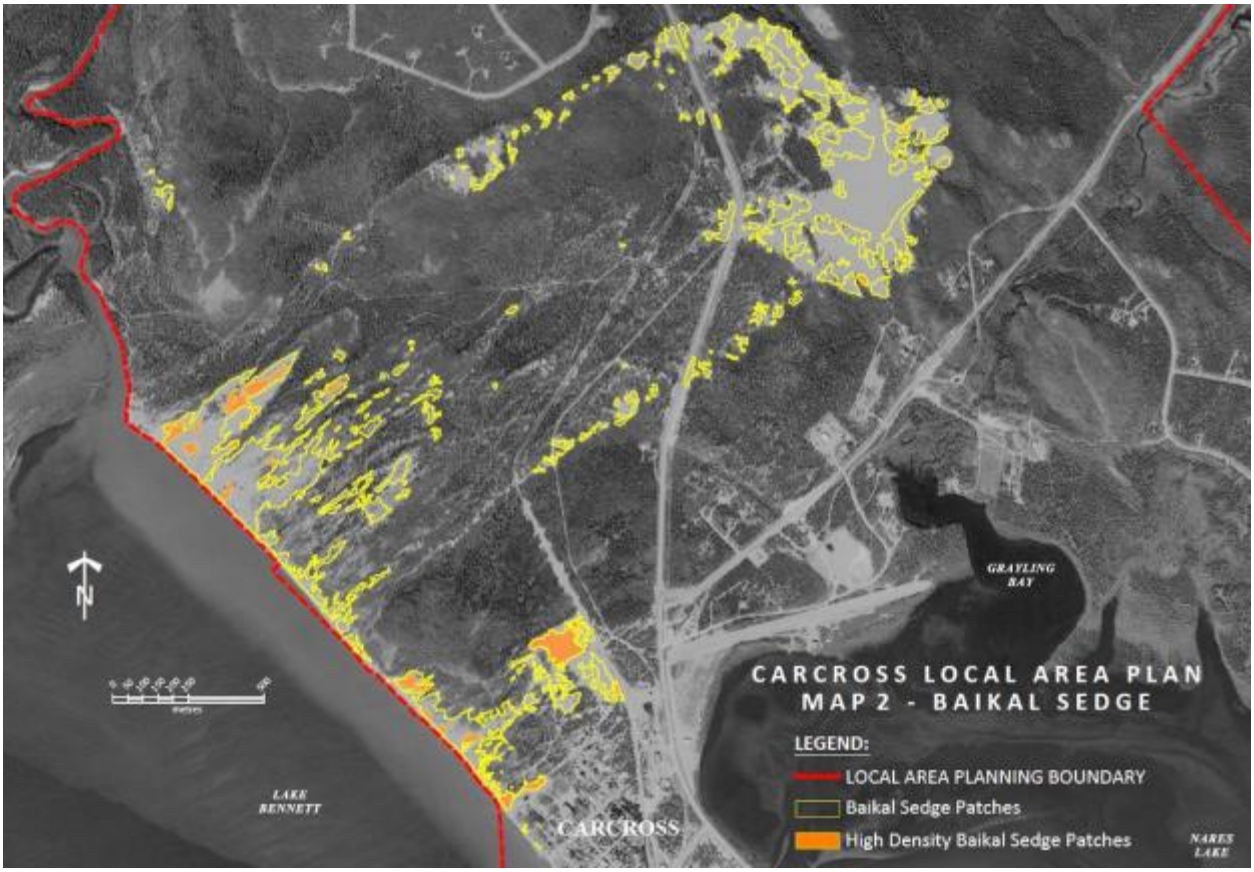

Figure 5. Distribution of Baikal Sedge in the Carcross dunes. Note that most of the high density patches are along or near the shoreline of Bennett Lake. The Klondike Highway traverses the image from the bottom to the centre top. Area under present development is the shoreline polygon immediately northwest of village centre (see Figure 10). Map from Carcross Local Area Plan (Yukon Government and Carcross/Tagish First Nation 2013).

Figure 6. Aerial view of the dune complex on the west side of the Takhini River, 6.8 km NNE of Kusawa Lake. Large dune is approximately 900 m long. Photo: J. Meikle; used with permission.

In Kluane National Park and Reserve, the largest subpopulation of Baikal Sedge (Alsek in Table 1) occurs on the semi-stabilized dunes near the confluence of the Kaskawulsh and Dezadeash rivers (Figures 7, 8; Douglas 1974; COSEWIC 2005). This subpopulation makes up a pioneer community on the dunes and appears to be relatively stable with minimal invasion by other plants on the dune edges. It is a relatively young community, because the site has been inundated many times by Lake Alsek. This pro-glacial lake, formed by the periodic damming of the Alsek River by the Lowell Glacier, existed as late as 1852, and would have been about 10 to 50 m deep at the present dune site (Kindle 1952; Johnson and Raup 1964; Clague and Rampton 1982). The sand deposits here were probably laid down as the lake drained in the 1850s (Bond pers. comm. 2014). A second Kluane subpopulation (Lower Alsek) occurs approximately 20 kms south, in less vegetated dunes alongside the Alsek River (Baikal Sedge Recovery Strategy 2012).

The sites west of Taye Lake and at the north end of Dezadeash Lake (Figure 9) are on dune fields blown upslope from the ancient beach and deltaic deposits of Glacial Lake Champagne. Similar sand deposits have been blown across the valley bottom and laid down around the Dezadeash River at Champagne (Bond pers. comm. 2014).

In general, Baikal Sedge is part of a community of plant species that can survive in the extreme conditions imposed by northern dunes. Common associates include Sand-dune Wheatgrass (*Elymus lanceolatus* ssp*. psammophilus*)*,* Pumpelly's Brome (*Bromus pumpellianus*), Northern Sweet Grass (*Anthoxanthum hirtum*)*,* Field Horsetail (*Equisetum arvense*), Showy Jacob's Ladder (*Polemonium pulcherrimum*), Field Locoweed (*Oxytropis campestris*),Yukon Lupine (*Lupinus kuschei*), Boreal Sage (*Artemisia borealis*), Aleutian Mugwort (*A. tilesii*), and Prairie Sagewort (*A. frigida*). Sparse tree cover is present in the dunes and around the edges of the Baikal Sedge occurrences; common species include Balsam Poplar (*Populus balsamifera*), Trembling Aspen (*Populus tremuloides*), and Lodgepole Pine (*Pinus contorta*).

At the Alsek site, Baikal Sedge has a mean cover of 15% and a frequency of 98% (in circular plots 15 m in diameter), and is the only prominent species in this community type (Figure 7; Douglas 1974). Another rare plant species, the Alaskan Bugseed (*Corispermum ochotense* var. *alaskanus),* occurs on these dunes. It occurs at only six other sites in Yukon (Yukon Conservation Data Centre 2016).

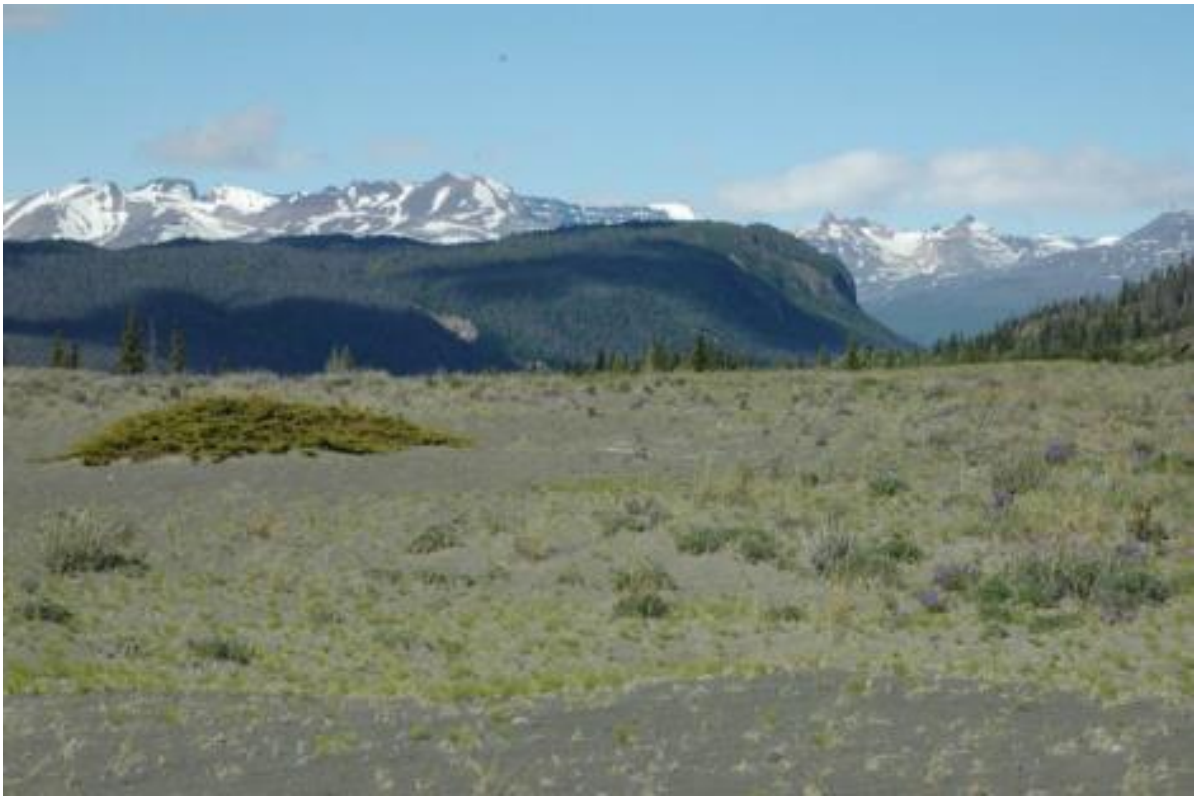

Figure 7. Alsek dunes at confluence of Kaskawulsh and Dezadeash rivers, Kluane National Park and Reserve. Photo: Syd Cannings.

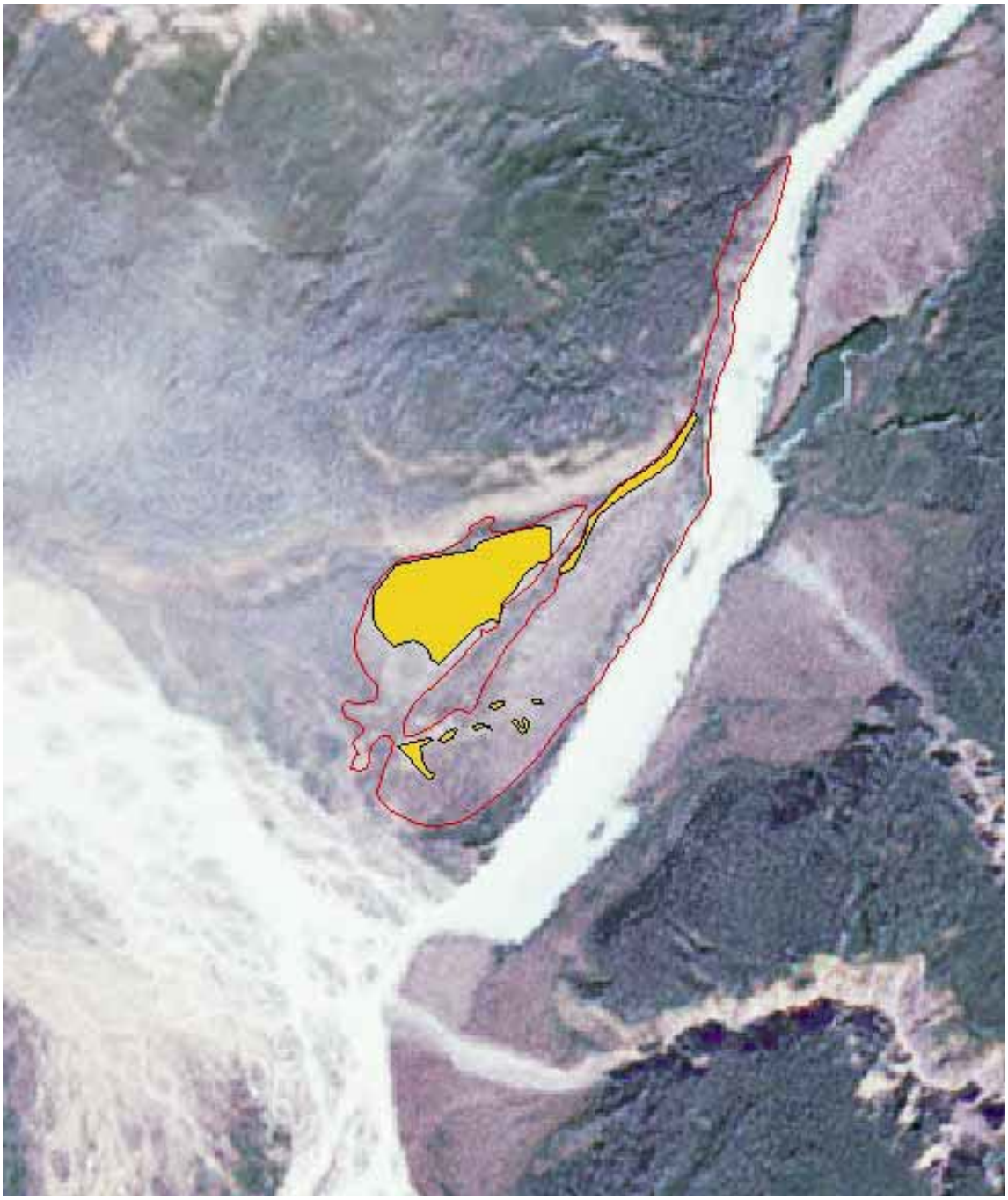

Figure 8. The distribution of Baikal Sedge (yellow) in the dunes at the junction of the Dezadeash (upper right) and Kaskawulsh (left) rivers; the rivers are flowing south (down). The long lobe of sand outlined in red on the right is largely stabilized and dominated by a Drummond's Mountain Avens (*Dryas drummondii*) community. The lobe on the upper left is a largely active dune, preferred by Baikal Sedge. Figure taken from Line and Freese (2006); used with permission.

Figure 9. Dune field on hillside north of Dezadeash Lake. Photo by Jennifer Line; used with permission.

At the Takhini River (Figure 6) and the Carcross dune systems, the dunes are generally much more active than those at the Kaskawulsh–Dezadeash confluence. Sand accumulations, however, are not greater than the species can tolerate. About 75% of these dunes were vegetated in 2003. On these dunes, Baikal Sedge is always the most prominent species and may occur with several other species or may be the sole species present. Other frequent but sparse dune species include Boreal Sage, Siberian Aster (*Eurybia sibirica*), Pumpelly's Brome, Purple Reed Grass, Sand-dune Wheatgrass, Field Horsetail, Yukon Lupine, Field Locoweed, Lodgepole Pine, Balsam Poplar, Showy Jacob's Ladder, Moss Campion (*Silene acaulis*) and Sticky Goldenrod (*Solidago simplex*).

The dune system along the Klondike Highway just north of Carcross includes some of the most active dunes in southwestern Yukon. Although there is evidence of invasion by Lodgepole Pine and Balsam Poplar, it is likely that sand movement eliminates about the same percentage of older trees. Most of the vegetation at the dunes consists solely of Baikal Sedge, but in some areas many of the species mentioned above can be found.

Habitat Trends

The dune habitat of Baikal Sedge has been substantially reduced since glaciation (Wolfe pers. comm. 2009; Figure 3). The reduction is mostly due to natural succession where dune formation is no longer able to overwhelm establishing plants. The dunes that remain are maintained by a large source of sand and consistent winds.

Air photos taken during the mid-1940s and between 1977 and 1999 indicate that all but one of the five largest extant dune systems remain unchanged. Only the Bennett Lake beach dunes, part of the Carcross dune field, show significant changes between 1948 and 1999. There appears to be a reduction of about 15 to 20% in dune area at this site (COSEWIC 2005).

The dunes at the junction of the Kaskawulsh and Dezadeash rivers (Alsek site in Table 1) in Kluane National Park are younger than most of the other dunes in the region, because they are located on the former site of Lake Alsek (see **Habitat Requirements** above). Portions of these young dunes now appear to be stabilizing as ecological succession proceeds (although there are no time sequence data), and it seems likely that the active dunes will be smaller in the future. The Lower Alsek dunes are likely more impacted by wind and may take longer to stabilize.

In contrast with this trend toward vegetation succession and dune stabilization, Douglas (in COSEWIC 2005) made the observation that, between 1974 and 2003, the large central area of the dunes along the Klondike Highway near Carcross has “remained mostly unvegetated.” In other words, he saw no noticeable decrease in vegetation at that particular site in recent decades. He reasoned that vegetation was not able to establish there because of the exceptionally strong winds that come off Bennett Lake and confront the southwest-facing slope below Caribou Mountain. This may be true for the primary, steeper slope, but local residents recall that, in general, the dunes next to the highway were more vegetated with grass and flowers in the 1970s than they are now (Mennell pers. comm. 2009). Similarly, botanist Bonnie Smith collected *Carex sabulosa* on the Carcross desert site in the 1980s and found it to be common; however, several years ago she could find no specimens of the species, presumably because of ATV use (Smith pers. comm. 2015). The photos in Figures 10 and 11 allow the comparison of the Carcross dunes at the Klondike Highway as they were in 1984 with their appearance in 2010. Today, there are only small patches of sparse grass and forbs in this part of the complex; even areas that are relatively flat are mostly completely devoid of vegetation (Figure 11). It is possible that up to 10 ha of formerly suitable habitat has been degraded; approximately 12% of the Carcross complex. The cause of this decline is undoubtedly the increase in recreational motorcycle and ATV traffic in that area in the past 30 years (Figure 12). Motorized traffic has also destroyed vegetation in small, linear portions of the Carcross beach dunes. Although it is difficult to quantify the rate of habitat destruction through ATV use, it will most likely continue increasing unless some form of effective management occurs.

Figure 10. Northern section of the Carcross dunes, east of the Klondike Highway, 1984. Compare vegetation with 2010 photo in Figure 11. Photo: C. Kennedy, used with permission.

Figure 11. Same view as Figure 10; 1 June 2010. Note apparently increased disturbance, smaller patches of vegetation, and virtual absence of vegetation on steeper, open slope. Photo: S. Cannings.

Figure 12. Off-road vehicle use at the Carcross dunes, east of the Klondike Highway. Baikal Sedge 'lawn' in foreground. Photo: Syd Cannings.

The dunes at sites not associated with lakes or rivers are kept open by strong winds that move the dune sand downwind. However, without new materials added to the system by water erosion, the blowouts created are small. These blowouts would be sensitive to changes in climate (especially moisture regimes and fire frequency; Bond pers. comm. 2014). They might also be sensitive to disturbance by large ungulates, especially Caribou (*Rangifer tarandus*); that is, the Caribou could maintain open blowouts through ongoing surface erosion. The Robinson dunes are a favoured wintering ground for the local Mountain Caribou herd. Both this herd and the much larger, wider-ranging Fortymile herd have declined substantially in the last century (Gronquist *et al.* 2005).

A small amount of habitat has been lost over the past decade in the vicinity of Carcross: there has been development and infill within the village, as well as a new boat launch ramp, water intake and beach viewing deck. Over the next decade, habitat declines are also expected to occur at Carcross as the result of residential development (see **THREATS AND LIMITING FACTORS** section). A planned development along the waterfront west of the present town site will affect up to 6% of the dune area (Yukon Environmental and Economic Assessment Board 2014). Ongoing fire suppression in the vicinity of communities also contributes to dune stabilization and habitat loss, although the magnitude of this contribution is difficult to assess.

Although invasion by exotic, dune-stabilizing plants has not affected much of the Baikal Sedge habitat in Yukon, habitat may be lost to these plants in the coming decades (see **THREATS AND LIMITING FACTORS**).

In summary, there is solid evidence of recent habitat decline only at Carcross. However, natural succession at the Alsek dunes appears to be causing a decline in active sand movement there.

BIOLOGY

The biology of Baikal Sedge has not been studied. It is evident, however, that this species can withstand high, desiccating winds and tolerates shifting sands, which can bury most of the clones. In this sense, it lives where it does because it can tolerate extreme conditions that most other plants cannot.

Life Cycle and Reproduction

Baikal Sedge populations are apparently maintained predominantly through reproduction by rhizomes producing clones (Line and Freese 2006). Single clones can cover a large area, which means there may not be many individual plants.

Seed production, on the other hand, may be naturally low—at one of the Takhini River dunes, Line (2011) estimated that only 5% of ramets had produced fruit (i.e., balloon-like perigynia on flowering stalks), and about 99% of these few fruits were sterile (i.e., no seed-like achenes had developed inside the perigynia). This was in the absence of a smut fungus infestation (see **Interspecific Interactions**). There is no known case of seed germination (Bennett pers. comm. 2015). 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 in at least some plants that a high rate of clonal propagation can positively affect genetic diversity, as long as monoclonal populations do not develop (Meloni *et al.* 2013).

Physiology and Adaptability

No information is available on the physiology of Baikal Sedge. Its inability to colonize new sites, and present restriction to a limited number of sites, suggest poor adaptability to changing conditions. However, it is adapted to extreme environments that are remnants of ice age landscapes when large glaciers and lakes covered much of the region. 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. It is likely that patches of ramets shift location within the dune as the dune slowly shifts downwind.

Though adapted to aeolian disturbance, the plants may not be adapted to the compaction of sand caused by development or recreational activities, which could limit the sedge's ability to reproduce by reducing the area where rhizomes could take hold. Baikal Sedge plays an important role in stabilizing sand dunes. These plants are usually some of the first to colonize loose sandy areas and, through their root systems, create an environment that allows for the establishment of other plants

Dispersal and Migration

Because it seems that Baikal Sedge in the Yukon rarely produces viable seeds (Line and Freese 2006), long-distance dispersal through seeds would be even rarer.

The habitat requirements for Baikal Sedge are such that isolated subpopulations are separated by tens to hundreds of kilometres of unsuitable habitat. Existing Baikal Sedge subpopulations mark the positions of glacial lakes formed 10,000 to 17,000 years ago when all modern sites of Baikal Sedge were connected by a series of glacial lakes and their spillways. The retreat of glaciers and decline in glacial lakes and spillways left Baikal Sedge habitats disconnected geographically.

Further genetic studies would be helpful to confirm that isolated patches of Baikal Sedge represent fragmented remnants of a retracting and formerly more extensive range (Environment Canada 2009).

Interspecific Interactions

Little is known about interspecific interactions, although Baikal Sedge is undoubtedly important to the overall dune ecosystem. At this time, its significance in the life cycle of other dune insects, plants or soil microorganisms is unknown.

Yukon subpopulations of Baikal Sedge are often infected by a smut fungus, which attacks developing achenes (Line and Freese 2006; Line 2011). The smut from plants at the Carcross dunes was identified as *Planetella lironis* Savile (Line and Freese 2006). Because these fungi are usually host-specific, this is likely the same species observed on Baikal Sedge in the Alsek subpopulation. At the north end of the unstable dune there, visible signs of infection from the smut were recorded on 57% (n=134) of the fruiting heads on October 2, 2006. On the southern third of this dune, however, only 14% of the fruiting heads appeared infected (Line and Freese 2006). The effect of the smut fungus on reproductive success of Baikal Sedge remains unknown (Line and Freese 2006).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

In the decade since the Baikal Sedge was assessed as Threatened in 2005, much searching, both focused and incidental, has resulted in a considerable increase in knowledge of this species in Canada. General search effort for new Baikal Sedge sites from 2009-2014 is detailed in Table 3.

For most of the smaller sites, subpopulation size estimates were made simply by rough counts (e.g., counting by tens or hundreds of ramets). At the Whitehorse (Riverdale) site, the abundance was estimated by counting ramets within sample plots in a low density area and again in a high density area, and extrapolating the results (Bennett pers. comm. 2015). The large Alsek site was enumerated by mapping the entire area in 10 x 10 m plots, and estimating the ramet density in each plot (Shepherd pers. comm. 2014).

Despite intensive mapping of the large Carcross site in 2009-2012, new population estimates were not made at this time. An estimate by George Douglas of 200,000 for the large lakeshore polygon in the southwest of the occurrence was used as a basis for the 200,000+ population estimate for the entire Carcross site in the 2005 COSEWIC report. However, as this estimate only applied to a portion of the site, it should be considered an underestimate. An additional 403,910 ramets were estimated in April 2016 by CWS staff (S. Dar and S. Stotyn) on 49 previously mapped polygons within the Carcross site (not including the large lakeshore polygon estimated by George Douglas). Therefore the revised population estimate for the Carcross occurrence is 603,910 ramets, although this should still be considered an underestimate given that not all mapped polygons at Carcross were evaluated, and additional unmapped polygons exist at the Carcross site.

Abundance

The total number of ramets (individual shoots in a clone) in Canada is estimated to be 4 to 4.5 million. The estimated number of ramets in each subpopulation is given in Table 1. The subpopulation at Carcross has not been estimated thoroughly; when this is done, the total population estimate will likely be somewhat higher, perhaps as high as 1,000,000 (Dar pers. comm. 2016).

Two of the sites, at Christmas Bay, Kluane Lake, and on a lake west of Kusawa Lake, have not been relocated, and are probably extirpated (COSEWIC 2005; Line and Freese 2006; Yukon Conservation Data Centre 2016).

Fluctuations and Trends

There is no direct information on population trends, but a relatively small rate of decline can be inferred based on declines in quantity and quality of habitat (see **Habitat Trends**).

Rescue Effect

Rescue of the Canadian population by propagules from Alaskan plants is unlikely, given the 1130 km distance and lack of appropriate habitat between these sites. It is also unknown whether viable seed is produced by the Alaskan population.

THREATS AND LIMITING FACTORS

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 Appendix 1. The assigned threat impact is Low.

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 rank was adjusted to Low (Appendix 1).

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 Negligible impact) are discussed.

Residential and Commercial Development (1)

Residential and commercial development is likely to impact Baikal Sedge only in the vicinity of Carcross, with two minor exceptions: one private holding at the edge of the Takhini dunes has a ‘lawn’ of Baikal Sedge, and the transfer station at Champagne may impact a nearby small dune.

<u>Housing and urban areas (1.1)</u>

Baikal Sedge occurs throughout the town site of Carcross at present, but Carcross is in a phase that is seeing land redeveloped and some natural edges lost.

As part of their Land Claims agreement, the Carcross/Tagish First Nation owns as settlement land a waterfront portion of the Carcross dunes (purple block along lakeshore in inset in Figure 13). Their development corporation is planning a residential development of 55 lots that will occupy 6.5 hectares of lakefront area immediately west of the present town site (Yukon Environmental and Economic Assessment Board 2014). Approximately 3.5 hectares of this area is made up of a Baikal Sedge dune community. This represents approximately 6% of the area of Baikal Sedge in Carcross, but some of this block has high densities of sedge, so the percentage of actual sedge plants impacted could be higher. Construction of the access road began in early 2015, and the development will be undertaken over the next decade. In their plans, the proponents provide mitigations to

reduce the effects of the project on the dune ecosystem, including leaving an area known to have Baikal Sedge free of development, and a no-build easement and boardwalk to protect the Baikal Sedge. However, there is no way of developing 55 lots in this area without removing some of the Baikal Sedge population there. As the Yukon Environmental and Economic Assessment Board document (Yukon Environmental and Socio-economic Assessment Board 2014) states, “there is a high likelihood that Baikal Sedge habitat will be affected by the proposed development and/or residential use of the greater area if ecologically important areas are not adequately protected.”

There is a large, high-density patch of Baikal Sedge north of the town site and adjacent to the White Pass and Yukon Route (WP&YR) right of way; most, if not all of this patch is on land owned by WP&YR (Figures 5, 13). This land is designated Residential Development in the 2013 Local Area Plan (LAP) for Carcross (Yukon Government and Carcross/Tagish First Nation 2013).

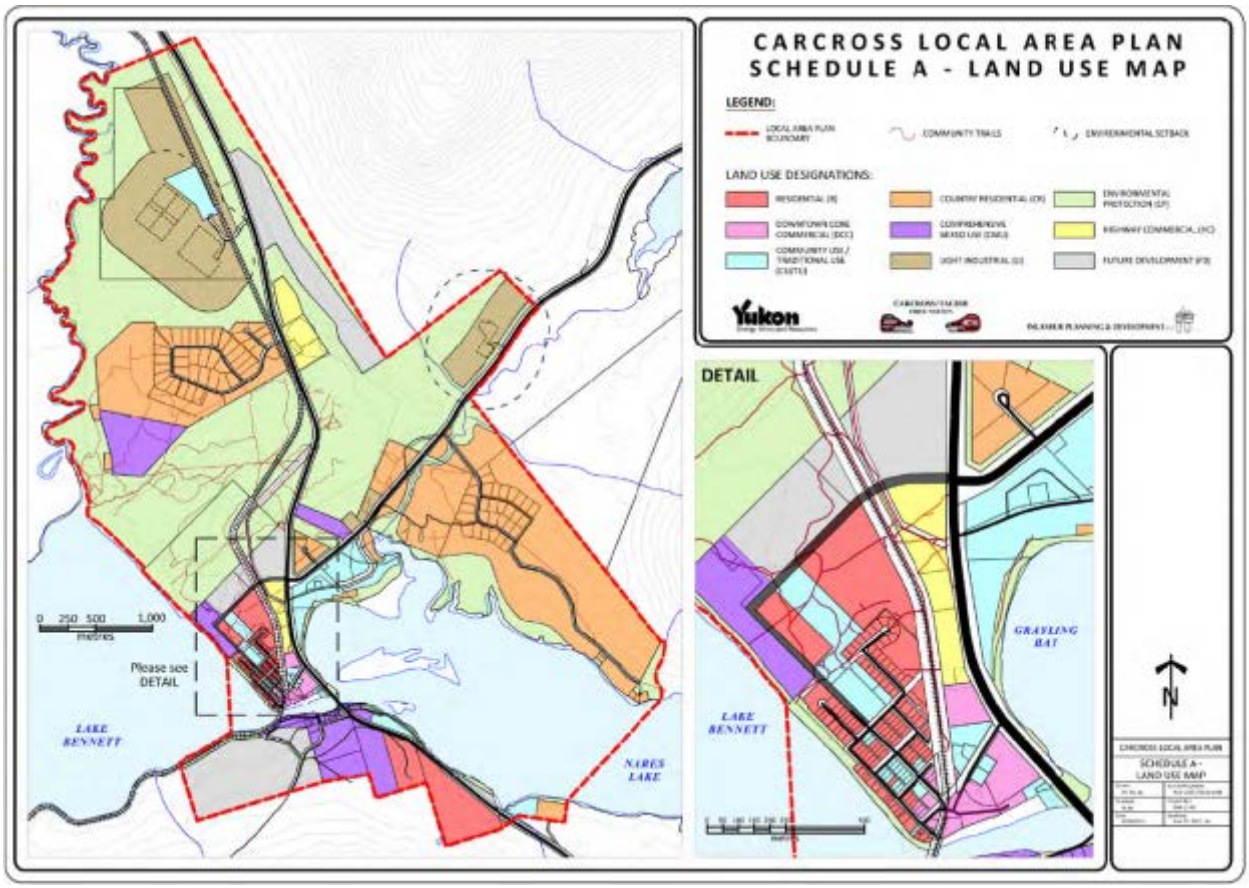

Figure 13. Carcross Local Area Plan land use map. Area under present development is purple block along Lake Bennett shoreline (see inset). Proposed route of second access road is grey line from four-way junction in north to present development. From Yukon Government and Carcross/Tagish First Nations (2013).

Additionally, there is a 27 ha parcel of land immediately behind the Bennett Lake beach dunes at Carcross that was previously zoned Tourist Commercial. This area was slated for a hotel and resort complex development in 2006, but that particular development did not come to fruition (see 1.3 below). In the 2013 LAP, this parcel is designated Comprehensive Mixed Use (Figure 13). As defined in the LAP, the purpose of this designation is “to encourage comprehensive developments that complement surrounding land uses while promoting vibrant, liveable, mixed-use designs in both built structures and overall neighbourhood development form.” Although the block is largely forested and a portion is underlain by bedrock rather than stabilized dunes, a future development here would likely impact the beach dunes through increased recreational use.

Finally, there is a block of land adjacent to the Carcross townsite that is designated Future Development (Figure 13). This block is largely stabilized, forested dunes. According to the LAP, the purpose of the Future Development designation is “to reserve lands in a largely natural state while maintaining flexibility for considering future land development options. Lands under this designation require further investigation of their development feasibility to determine if, when, and how development may occur.”

Tourism and recreation areas (1.3)

COSEWIC (2005) stated that a large hotel and resort complex was planned for construction in 2006 near Carcross, just north of the Bennett Lake beach dunes. While that complex was not built, another resort is now planned for Millhaven Bay, a short distance to the south of the dunes, on the west side of Bennett Lake. Although Baikal Sedge is not known from the dunes of Millhaven Bay, these planned developments illustrate the potential growth in tourism and tourist facilities in the immediate area of Carcross. At present this threat is deemed to have Negligible impact.

Transportation and Service Corridors (4)

Roads and railroads (4.1)

The White Pass and Yukon Route railway right of way bisects the Carcross and Robinson dunes. However, the railway north of the Carcross town site is not used at present.

A second road access to Carcross is in the planning stages; this road is intended to help with traffic flow in and out of the community, especially during emergencies when a train could be blocking the main entrance in the village core (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 13). The Local Area Plan 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).

Human Intrusions and Disturbance (6)

Recreational activities (6.1)

Threats of disturbance from recreational use are primarily of concern at Carcross and at the small dune blowouts in Riverdale (Whitehorse) and Robinson. The dunes north of Carcross at the Klondike Highway receive intensive use by off-road enthusiasts: all-terrain vehicles and motorcycles in the summer and snow machines in the winter (Figure 12). Heavy use continually destroys the upper portion of the plants and compacts the sand, and can eliminate Baikal Sedge clones. There is some evidence that the increased use there in the past two decades has resulted in a noticeable decline in dune vegetation (Figures 10, 11). Since 2007, a local tour company has been offering summer all-terrain vehicle excursions through the dunes near the Klondike Highway, but it appears the tours generally follow the same path each time and so do little damage outside their established route.

It is estimated that up to thirty snow machines can be using the dunes during a given winter weekend (Baikal Sedge Recovery Team 2012). Snow is often thin along the dune crest, and erosion of sand has been observed in Carcross as a result of snow machine use (Baikal Sedge Recovery Team 2012). Additionally, these machines may compact the sand beneath the thin snow layer. Monitoring is required to develop a clearer understanding of the effects of snow machines.

At Carcross, off-road vehicle use on the Bennett Lake beach dunes is less intensive than it is on the dunes along the Klondike Highway, but it does occur and is apparently increasing (Mennell pers. comm. 2014).

Although the dune area in Riverdale is posted as a no-motorized-vehicle area, it is within the city of Whitehorse and is used by motorbikes on a regular basis. It is also a popular tobogganing area. Much of the area has been completely torn up and eroded by these activities, and some Baikal Sedge has undoubtedly been eliminated. It is difficult to quantify the threat at present. Mountain biking has also become extremely popular in Whitehorse and now may pose an additional threat, even though the impact of an individual rider would be far less than that of a motorized bike.

The dunes along the Takhini River downstream of Kusawa Lake are accessible from the Kusawa Lake road and are used occasionally by off-road vehicles. However, the dunes are not visible from the road and access is through a private driveway, which perhaps discourages some riders. This area is part of the new Kusawa Lake Territorial Park; in the draft management plan for the park, “all park activities will give consideration to sensitive, vulnerable or otherwise important habitat areas and ecosystems,” and management of the dunes for the benefit of Baikal Sedge is listed as a high priority. Enforcement of any policies would be difficult, however, in this wilderness setting.

There is perhaps some impact by guided hunting trips on horseback through the Rose Creek dune system, but it is probably negligible. Impacts of off-road vehicles are of little concern at the Kaskawulsh-Dezadeash dunes, which are relatively remote and located within the Kluane National Park and Reserve.

Natural System Modifications (7)

Fire and fire suppression (7.1)

No studies have been made on the effects of fire suppression, but it is likely that it would result in accelerated dune stabilization by natural succession where dunes are no longer constantly supplied with additional sand. In Yukon, wild land fire suppression normally only 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.

Invasive and Other Problematic Species (8)

Invasive non-native/alien species (8.1)

Perhaps the greatest future threat to Baikal Sedge in Canada is the establishment of invasive plant species; however, the impact is deemed to be Unknown at present (Appendix 1). 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; Bennett pers. comm. 2016). White Sweet-clover (*Melilotus albus*) is also beginning to invade the Dezadeash River corridor and it could move downstream to the subpopulations in Kluane National Park and Reserve. Both of these invasive species could compete with Baikal Sedge because they also thrive in loose sand. Based on the behaviour of these invasive species in other jurisdictions, the effects of their establishment at the Yukon dunes could be significant in a very short time period (Baikal Sedge Recovery Team 2012).

Problematic native species (8.2)

Dune stabilization through plant succession is an important limiting factor for Baikal Sedge populations. In some cases, stabilization may be the result of human activities and, in those cases, could be considered a threat. One of these is fire suppression, which is discussed in 7.1 above. Another could be the dramatic reduction in Caribou numbers through overhunting over the past century; however, the previous effects of the larger Caribou numbers on the maintenance of open dunes is unknown.

A native smut fungus (see **Interspecific Interactions**) reduces seed production, but this is a limiting factor rather than a threat.

At the Alsek dunes, the Baikal Sedge plant community (Figure 7) likely leads a precarious existence. This dune system is recent in origin; the sand was laid down there during the catastrophic draining of a glacially dammed lake in the 1850s (Clague and Rampton 1982). Although the winds in this corridor are persistent and strong, the two rivers do not expose a lot of new sand at this site (Figure 8), and succession is clearly occurring around the periphery of the dunes. Changes to the dunes could come through natural succession, or climate change that might affect the glaciers, and subsequent changes in wind speeds, along the Alsek River.

Geological Events (10)

Avalanches/landslides (10.3)

The largest subpopulation of Baikal Sedge at the confluence of the Dezadeash and Kaskawulsh rivers grows on sand laid down by the catastrophic draining of Recent Lake Alsek, about 160 years ago. This lake was formed many times in the past, whenever the massive Lowell Glacier surged and blocked and dammed the Alsek River. Although the Lowell Glacier may surge and dam the river in the future, the resulting lake is unlikely to reach the main Baikal Sedge populations at the confluence of the Kaskawulsh and Dezadeash rivers, because the mass and depth of the Lowell Glacier has diminished considerably in recent decades (Bond pers. comm. 2014).

Number of Locations

It is difficult to define locations based on threats that can rapidly affect all individuals at sites in a short time as the most plausible threats will act slowly. Most of the 16 occurrences of Baikal Sedge in Canada (defined as those sites greater than 1 km distant from one another) are primarily threatened by succession, as a result of fire suppression, and invasion by exotic species. Some of these occurrences might become extirpated or severely impacted in less than three generations (15-21 years), but all could not be eliminated. The Carcross dunes are threatened as well by development and disturbance by off-road vehicles, but this is a large subpopulation that likely could not be severely impacted in a short time. There is a possibility that the two subpopulations in the Alsek River valley could be eliminated quickly through a glacier dam creating a large lake, but this scenario is increasingly unlikely as climate warming and resulting glacial down-wasting occurs.

Considering each known occurrence as a separate location based on the likelihood that threats would be site-specific results in 16 locations. If a separation of three km is used, considering that invasive species or fire might cover a larger area, then there are 13 locations. Carcross could be considered to have multiple locations due to the various threats acting there. As such, the most plausible number of locations for this species is 13 to 16.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Baikal Sedge is listed as Threatened on Schedule 1 of the federal *Species at Risk Act* (SARA). However, in the Yukon, SARA's automatic prohibitions against killing and harming only apply on lands under the jurisdiction of the federal minister of environment; in the case of Baikal Sedge, these lands are limited to the occurrences within Kluane National Park and Reserve.

Critical Habitat has only been identified and mapped within Kluane National Park and Reserve (Baikal Sedge Recovery Team 2012).

Non-Legal Status and Ranks

Baikal Sedge is ranked as S1 (critically imperiled) in Alaska (Alaska Natural Heritage Program 2014). There, it occurs at one site in a protected area, the Koyukuk National Wildlife Refuge. It is not covered under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) or the *Endangered Species Act* (USA), and has not been assessed for the IUCN Red List. NatureServe (2014) has given this species a global rank of G5, indicating that it is demonstrably secure.

In Yukon, Baikal Sedge is ranked S3, or sensitive (Yukon Conservation Data Centre 2016). The national rank for Canada is thus N3. For a full explanation of NatureServe ranks see Master *et al*. (2009).

Habitat Protection and Ownership

The Kluane National Park and Reserve subpopulations receive protection under the *Canada National Park Act*. At this time, Critical Habitat under the *Species at Risk Act* has been mapped only within this park. At the Alsek dunes, Critical Habitat has been defined as all areas with at least moderately robust and healthy plants at any density, plus areas with plants in poor health but at medium density (100 or more ramets per 10 m^2). Areas with sparse, less robust plants are excluded (Baikal Sedge Recovery Team 2012). This definition means that roughly half the occupied dunes are considered Critical Habitat. First Nations activities related to access and harvesting rights (including off-trail ATV use for transportation) will be allowed through the dunes outside the Critical Habitat. At the smaller population farther down the Alsek River, all Baikal Sedge plants are included within Critical Habitat.

The subpopulation in the Takhini River dunes is now contained within the proposed Kusawa Territorial Park. Although this park has not yet been formally established under the *Yukon Parks and Land Certainty Act*, the area within the park has been permanently withdrawn from mineral and oil and gas exploration. A management plan is being developed for the park; one of the objectives of the proposed park (as stated in the Carcross/Tagish First Nation and Kwanlin Dun First Nation final agreements) is “to protect for all time a natural area of territorial significance” (Environment Yukon 2015).

The area of the Carcross dunes east of the South Klondike Highway has been reserved for future park purposes as the Carcross Desert Territorial Park Reserve. Past efforts to establish and manage a Territorial Park in this area have not been pursued due to local opposition, but recently there is a renewed interest in the area becoming a Territorial Park (Yukon Government and Carcross/Tagish First Nation 2013). However, if this is proclaimed as a park in the future, park management would have to address the issue of off-road vehicle disturbance if Baikal Sedge were to be protected.

The larger, less impacted dune system on the western side of the highway is not protected but a good portion of it falls on lands designated under Environmental Protection in the Local Area Plan (Figure 13; Yukon Government and Carcross/Tagish First Nation 2013). The Plan states that the purpose of this designation is “to protect areas of ecological significance from incompatible development by preserving land largely in its natural state.”

Ownership of the various sites is detailed in Table 1.

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

The report writer wishes to acknowledge the work of the late George W. Douglas, who wrote the first COSEWIC report. Pippa Shepherd of Parks Canada led the Recovery Team for this species and pulled together much of the new information in the Recovery Strategy. Jennifer Line led much of the recent fieldwork studying this species in Yukon. Randi Mulder and Bruce Bennett provided valuable information from the Yukon Conservation Data Centre. Recent fieldwork was done with the valued efforts of John Meikle, Lawrence Joe, Alanna Dickson, Jason Jim, Gary Johnson, Art Johns, Geraldine Pope, Lori Schroeder, Lee Mennell, Saleem Dar, Shannon Stotyn, Catherine Kennedy, Afan Jones, and Catherine Pinard.

Recent (2006-2015) fieldwork was funded by Parks Canada Agency and by Environment Canada (Canadian Wildlife Service), with direct funding and through the Aboriginal Fund for Species at Risk (AFSAR), with grants to the Champagne and Aishihik First Nations, Kwanlin Dun First Nation, Carcross/Tagish First Nation, and Kluane First Nation.

INFORMATION SOURCES

Alaska Natural Heritage Program. 2014. Vascular Plant Tracking List. Available at: http://aknhp.uaa.alaska.edu/botany/rare-plants-species-lists/rare-vascular-hulten/. [accessed October 3, 2014].

Baikal Sedge Recovery Team. 2012. Recovery Strategy for the Baikal Sedge (*Carex sabulosa*) in Canada. *Species at Risk Act* Recovery Strategy Series. Parks Canada Agency, Ottawa, vi + 22pp.

Ball, P.W., and A.A. Reznicek. 2002. *Carex*. Pages 254-572. In Flora of North America North of Mexico. Volume 23. Cyperaceae. Edited by Flora of North America Editorial Committee. Oxford University Press Incorporated, New York, New York. 608 pp.

Bennett, B., pers. comm. 2014. *Verbal conversation with S. Cannings..*Coordinator, Yukon Conservation Data Centre.

Bennett, B., pers. comm. 2015. *Verbal conversation with S. Cannings.* Coordinator, Yukon Conservation Data Centre.

Bennett, B., pers. comm. 2016. *Verbal conversation with S. Cannings.* Coordinator, Yukon Conservation Data Centre.

Bond, J., pers. comm. 2014. *Email to S. Cannings..*Manager, Surficial Geology, Yukon Geological Survey.

COSEWIC 2005. COSEWIC assessment and status report on the Baikal Sedge *Carex sabulosa* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 23 pp.

COSEWIC. 2011. COSEWIC assessment and status report on the Dune Tachinid Fly *Germaria angustata* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 43 pp.

Clague, J.J., and V.N. Rampton. 1982. Neoglacial Lake Alsek. Canadian Journal of Earth Sciences 19:94-117.

Cody, W.J. 2000. Flora of the Yukon Territory. 2nd Edition. National Research Council Press, Ottawa, Ontario. 669 pp.

Dar, S., pers. comm. 2016. *Email to S. Cannings.* Northern Liason Biologist, Canadian Wildlife Service.

Douglas, G.W. 1974. Montane zone vegetation of the Alsek River region, southwestern Yukon. Canadian Journal of Botany 52:2505-2532.

Environment Yukon. 2015. Kusawa Park draft management plan ready for review. Available at: http://www.kusawapark.ca/news/archive/kusawa-park-draft-management-plan-ready-for-review. [accessed 28 January 2016].

Gronquist, R.M., T.L. Haynes, and C.L. Gardner. 2005. Rebuilding the Fortymile caribou herd: a model of cooperative management planning. Rangifer, Special Issue No. 16:163-175.

Hultén, E. 1968. Flora of Alaska and neighboring territories. Stanford Univ. Press, Stanford. 1008 pp.

Johnson, F., and H.M. Raup. 1964. Investigations in the southwest Yukon: geobotanical and archaeological reconnaissance. Pap. Robert S. Peabody Foundation of Archaeology. Vol. 6.

Kindle, E.D. 1952. Dezadeash map area, Yukon Territory, Canada. Can. Mem. 268.

Lesica, P., and F.W. Allendorf. 1995. When are peripheral populations valuable for conservation? Conservation Biology 9: 753-760.

Line, J. 2011. 2009-2010 Baikal Sedge Inventories on the Traditional Territories of the Carcross-Tagish, Champagne and Aishihik, Kwanlin Dun and Kluane First Nations, Yukon, Canada. Internal unpublished report prepared for: Carcross-Tagish First Nation, Champagne and Aishihik First Nations, Kwanlin Dun First Nation and Kluane First Nation. 25 pp. + appendices.

Line, J., and L. Freese. 2006. The status of Baikal Sedge (*Carex sabulosa*) in Kluane National Park and Reserve: results of the 2006 inventory. Parks Canada unpublished report. 23 pp.

Master, L., D. Faber-Langendoen, R. Bittman, G.A. Hammerson, B. Heidel, J. Nichols, L. Ramsay, and A. Tomaino. 2009. NatureServe conservation status assessments: factors for assessing extinction risk. NatureServe, Arlington, VA. <http://www.natureserve.org/publications/ConsStatusAssess_StatusFactors.pdf> [Accessed September 2015].

Mayr, E. 1982. Adaptation and selection. Biologisches Zentralblatt 101:161-174.

Meloni, M., A. Reid, J. Caujapé-Castells, Á. Marrero, J. M. Fernández-Palacios, R. A. Mesa-Coelo, and E. Conti. 2013. Effects of clonality on the genetic variability of rare, insular species: the case of Ruta microcarpa from the Canary Islands. Ecology and Evolution 3: 1569-1579.

Mennell, R.L. 2009, pers. comm. *Email to S. Cannings.* Biological consultant.

Murray, D.F. 2002. *Carex* sect. Racemosae, Pages 401-414. *In* Flora of North America Editorial Committee, eds. Flora of North America North of Mexico - Volume 23. Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press Inc., New York,NY.

NatureServe. 2014. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. [accessed: October 1, 2014].

Porsild, A.E. 1966. Contributions to the flora of southwestern Yukon Territory. National Museum of Canada, Contributions in Botany 4:1-86.

Raymond, M. 1965. Cyperaceae. *In* M. Koie and K.H. Rechinger, eds. Sybolae Afganicae VI. Biol. Skr. 14:5-35.Schroeder, L. 2009. Baikal sedge (*Carex sabulosa*) fine scale mapping in the Carcross area. A report prepared for Environment Yukon.

Salafsky, N., D. Salzer, A. J. Stattersfield, C. Hilton-Taylor, R. Neugarten, S. H. M. Butchart, B. Collen, N. Cox, L. L. Master, S. O'Connor, and D. Wilkie. 2008. A standard lexicon for biodiversity conservation: unified classifications of threats and actions. Conservation Biology 22:897-911. (Classification online at http://conservationmeasures.org/CMP/IUCN/browse.cfm?TaxID=DirectThreats.).

Shepherd, P. 2014, pers. comm. *Conversation with S. Cannings..*Ecosystem Scientist, Parks Canada Agency.

Smith, B.M. 2015, pers. comm. *Email to B.R. Bennett 18 February 2015.* Botanist.

Stotyn, S. 2014, pers. comm. *Conversation with S. Cannings.* Species at Risk Biologist, Canadian Wildlife Service, Whitehorse.

Wolfe, S.. 2009, pers. comm. *Email to S. Cannings..*Research Scientist, Geological Survey of Canada.

Welsh, S.L. 1974. Anderson's flora of Alaska and adjacent parts of Canada. Brigham Young Univ. Press, Provo. 724 p.

Wu, Z., and P.H. Raven (eds.). 2010. Flora of China, Vol. 23. Available at: http://www.efloras.org/florataxon.aspx?flora_id=2&taxon_id=242357441 [accessed 3 October 2014].

Yukon Environmental and Socio-economic Assessment Board. 2014. Designated Office Evaluation Report. Carcross Tagish C-31 FS Rural Residential Subdivision. Project Number: 2013-0097. Whitehorse, Yukon. 64 pp.

Yukon Conservation Data Centre. 2016. Rare species database. Yukon Department of Environment, Whitehorse, Yukon. Website www.env.gov.yk.ca/cdc [accessed 1 February 2016].

Yukon Government and Carcross/Tagish First Nation. 2013. Carcross local area plan. Available at: http://issuu.com/yukon_energy_mines_resources/docs/carcross_local_area_plan_october_20 [accessed 4 December 2014].

BIOGRAPHICAL SUMMARY OF REPORT WRITER(S)

Syd Cannings is a Species at Risk Biologist in the Canadian Wildlife Service in Whitehorse. He received his MSc in Zoology at the University of British Columbia in 1978. Following graduation, he became the curator of the Spencer Entomological Museum, the major insect collection at UBC. Beginning in 1991, he spent 11 years as the Program Zoologist for the BC Conservation Data Centre in Victoria and became interested in assessing the status of species at risk. From 2000 to 2003 he was a Research Zoologist for NatureServe, ranking, compiling data and establishing data standards for birds and mammals throughout North America. Over the years, Syd has collaborated with his brothers on a number of books, including: *Birds of the Okanagan Valley, British Columbia; British Columbia: A Natural History; The New BC Roadside Naturalist; Geology of British Columbia;* and *The World of Fresh Water.*

COLLECTIONS EXAMINED

None.

Appendix 1. Threats Assessment for Baikal Sedge.

Species or Ecosystem Scientific Name	*Carex sabulosa*	
Element ID		**Elcode**
Date (Ctrl + ";" for today's date):	14/01/2016	
Assessor(s):	Syd Cannings, Dwayne Lepitzki, Del Meidinger, Bruce Bennett, Tom Jung, Todd Powell, Saleem Dar, Pippa Sheppard, Nathalie Leclerc, Phil Emerson, John Miekle, Jim Pojar, Eric Lamb, Andy MacKinnon, Michael Jim, Karen Timm	
References:	draft document submitted by Syd Cannings was revised by participants on the call.	

Overall Threat Impact Calculation Help:

	Threat Impact		**Level 1 Threat Impact Counts**	
			high range	**low range**
	A	Very High	0	0
	B	High	0	0
	C	Medium	0	0
D	D	Low	4	4
		Calculated Overall Threat Impact:	Medium	Medium

Assigned Overall Threat Impact:	**D = Low**
Impact Adjustment Reasons:	Because the 'low' threats are closer to the low end, once rolled up, the group decided to modify to Low to better reflect the impact to the population.
Overall Threat Comments	***Generation time 5-7 years, up to 12 years.***

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development	D	Low	Small (1-10%)	Extreme (71-100%)	High (Continuing)	
1.1	Housing & urban areas	D	Low	Small (1-10%)	Extreme (71-100%)	High (Continuing)	Residential development in Carcross; also the lower potential for impacts of development at other sites. Closer to the lower end of the scope estimate, but negligible is not appropriate. Severity may be closer to 70% than 100% but it is not Serious. Note the Carcross subpopulation may be an underestimate; may be up to 500 000, but area impacted not > 10% of population.
1.2	Commercial & industrial areas		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	Commercial development in Carcross; lower potential for impact also near transfer station at Champagne site.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1.3	Tourism & recreation areas		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	Tourism development in the Carcross area. Maintenance of existing sites is a possible impact.
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture						
3	Energy production & mining						
3.1	Oil & gas drilling						
3.2	Mining & quarrying						
3.3	Renewable energy						
4	Transportation & service corridors		Negligible	Negligible (<1%)	Extreme (71-100%)	Moderate (Possibly in the short term, < 10 yrs)	
4.1	Roads & railroads		Negligible	Negligible (<1%)	Extreme (71-100%)	Moderate (Possibly in the short term, < 10 yrs)	Development of second access road into Carcross is noted in community development plan. Road might create dunes eventually, but immediate impact through destroying plants.
4.2	Utility & service lines						
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use		Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						Used to be collected in past for traditional medicinal uses, but not to the same extent presently. Still collected for research presently as a showy plant, but insignificant.
5.3	Logging & wood harvesting		Not a Threat	Negligible (<1%)	Neutral or Potential Benefit	High (Continuing)	Some logging and wood harvesting at some sites (Robinson) but may be of potential benefit (may activate dunes). Note permits may not be granted at Carcross for this activity at sensitive sites.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	
6.1	Recreational activities	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	Main impact is threat of off-road motorized vehicle use at Carcross, Whitehorse, and at part of Takhini River dunes. Most of Canadian population can be exposed to the much smaller threat of walking and biking (fat bikes), cross-country skiing and tobogganing, but scope is very small presently, but may increase into future. Scope is based on all threats listed. Subsistence hunting where horses are used to access backcountry was discussed. Appropriate mitigations planned for Territorial park to prevent ATV use.
6.2	War, civil unrest & military exercises						
6.3	Work & other activities						Some subsistence hunting (not recreation) is taking place but likely of low impact to plants. Research collecting, but insignificant re: scope and severity.
7	Natural system modifications	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	
7.1	Fire & fire suppression	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	Fire suppression allowing forests to establish on less active dunes. Scope may be closer to the lower estimate. Increased fire frequency is expected (lightning strikes) with climate change, but may be of benefit as it would remove woody growth.
7.2	Dams & water management/use						
7.3	Other ecosystem modifications						
8	Invasive & other problematic species & genes	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.1	Invasive non-native/alien species		Unknown	Small (1-10%)	Unknown	Moderate (Possibly in the short term, < 10 yrs)	Invasive grasses and White Sweet-clover at Carcross. Altai Wild Rye adjacent to dunes at Carcross and may move quickly once established. White Sweet-clover is also beginning to invade the Dezadeash River corridor and it could move downstream to the subpopulations in Kluane National Park and Reserve. At present time this is a looming threat rather than a current one. Smooth Brome also is a problem.
8.2	Problematic native species	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	Caribou are not maintaining the blowouts through ongoing surface erosion - caribou numbers are declining, however (not expected to increase in next 10 years). Caribou usage of dunes was discussed, but extent of use to drive decline of dunes is uncertain. The severity estimate is at the lower end of the range selected. Natural succession at Alsek dunes, and at Robinson, Taye, Dezadeash Lake, etc. is considered as a limiting factor. Native Smut fungus causing reduction in seed production - but this is a limiting factor.
8.3	Introduced genetic material						
9	Pollution						Pollution is not a threat to this species.
9.1	Household sewage & urban waste water						
9.2	Industrial & military effluents						
9.3	Agricultural & forestry effluents						
9.4	Garbage & solid waste						
9.5	Air-borne pollutants						
9.6	Excess energy						
10	Geological events		Negligible	Negligible (<1%)	Extreme (71-100%)	Moderate - Low	
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
10.3	Avalanches/landslides		Negligible	Negligible (<1%)	Extreme (71-100%)	Moderate - Low	There is a possibility of the Lowell Glacier surging and damming the Alsek River again. However, if this were to happen, the resulting lake is unlikely to reach the main Baikal Sedge subpopulations at the confluence of the Kaskawulsh and Dezadeash Rivers, because the mass and depth of the Lowell Glacier has diminished considerably in recent decades.
11	Climate change & severe weather		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Climate change evident in Yukon but impacts on sedge unknown. With wetter weather, dune stabilization would likely increase.
11.1	Habitat shifting & alteration						
11.2	Droughts						
11.3	Temperature extremes						
11.4	Storms & flooding						
Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).							