COSEWIC
Assessment and Status Report

on the

Yukon Draba
Draba yukonensis

in Canada

SPECIAL CONCERN
2018

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. 2018. In Press. COSEWIC assessment and status report on the Yukon Draba *Draba yukonensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 41 pp. (http://www.registrelep-sararegistry.gc.ca/default.asp?lang=en&n=24F7211B-1).

Previous report(s):

COSEWIC. 2011. COSEWIC assessment and status report on the Yukon Draba *Draba yukonensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. viii + 31 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

Production note:
COSEWIC would like to acknowledge Syd Cannings for writing the status report on Yukon Draba, *Draba yukonensis*, prepared under contract with Environment and Climate Change Canada. This report was overseen and edited by Danna Leaman, Non-government Science COSEWIC Member, with assistance from Jana Vamosi and Del Meidinger, Co-chairs of the COSEWIC Vascular Plants Subcommittee.

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur le Drave du Yukon (*Draba yukonensis*) au Canada.

Cover illustration/photo:
Cover photo of Yukon Draba by Syd Cannings, 5 June 2012, Aishihik, Yukon.

Catalogue No. CW69-14/648-2019E-PDF
ISBN 978-0-660-31345-0

COSEWIC
Assessment Summary

Assessment Summary – November 2018

Common name
Yukon Draba

Scientific name
Draba yukonensis

Status
Special Concern

Reason for designation
This small, short-lived perennial mustard species is endemic to the southern Yukon. It has a very restricted distribution limited to well-drained meadows and south-facing slopes. Surveys undertaken since 2011 increased the area of distribution and number of known sites from 3 to 19, and indicate that the population may not undergo extreme fluctuations as previously thought. Present threats include forest encroachment, wildfire, invasive species, and trampling by humans and bison. These threats have the potential to reduce the area of suitable habitat and numbers of potentially unviable subpopulations enough to qualify the species for Threatened status.

Occurrence
Yukon Territory

Status history
Designated Endangered in November 2011. Status re-examined and designated Special Concern in November 2018.

COSEWIC
Executive Summary

Yukon Draba
Draba yukonensis

Wildlife Species Description and Significance

Yukon Draba is a small herb in the mustard family with untoothed leaves covered with distinctive stiff, unforked hairs. Individual plants have a small taproot, one or more rosettes of leaves that lie on the soil, and one or more flower-bearing stems. The flowers are small, white, and have four petals.

Distribution

Yukon Draba is endemic to the southwestern Yukon, and is known from 19 sites at present.

Habitat

Yukon Draba grows on dry, well-drained meadows. The meadows are often on ancient beaches and spits formed at the edge of proglacial lakes. Where it is found on steep, south-facing slopes, it is often restricted to the top and/or the bottom of the slope, where the conditions are less dry than the mid-slope.

Biology

Little is known about the biology of Yukon Draba, but recent monitoring data indicate that it is a short-lived perennial. It appears to be tolerant of dry conditions and direct sun. The ability of Yukon Draba to disperse via seeds is likely quite limited. Seed damage from small mammal and insect herbivory has been observed.

Population Sizes and Trends

The population is estimated to be about 160,200 to 333,000 individuals. Great variation in the number of flowering individuals can occur between years, but recent monitoring efforts (2012-2017) suggest that the population itself does not undergo extreme fluctuations. There is no information on long-term trends.

Although the great majority of mature individuals occur in two large subpopulations, the majority of known sites have small, isolated subpopulations with unknown viability.

Threats and Limiting Factors

Multiple factors (including fire suppression, reduction of herbivore populations, and impacts of climate change) are apparently leading to habitat loss via the shrubification and afforestation of some Yukon grasslands. Conversely, climate change may also result in an increase in forest fires, and these fires would help maintain open grasslands.

Bison were reintroduced to the region in the 1980s, and increasing bison numbers will result in more trampling, heavier grazing and burial of plants in droppings. Although trampling and grazing may kill individual plants, this also helps to keep grasslands open.

Traffic is increasing on the small dirt road that has long traversed the largest Yukon Draba subpopulation at the Alsek Meadow, and habitat disturbance related to this traffic may increase as well. In 2011, an exploration company established mining claims on the meadow to upgrade this road to facilitate mining operations and provide access to mining properties. The mining company subsequently (2013) entered into a security agreement with the Yukon government, which essentially prohibits mining on these claims.

Protection, Status, and Ranks

COSEWIC assessed Yukon Draba as Special Concern in 2018; it was previously assessed as Endangered in 2011. It currently has no legal protection or status in Canada or the US. It is not listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

NatureServe considers Yukon Draba to be globally imperilled to vulnerable (G2G3); the same rank applies at the national (N2N3) and territorial (S2S3) scales.

TECHNICAL SUMMARY

Draba yukonensis

Yukon Draba

Drave du Yukon

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

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 (2017) is being used)	2-3 years
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes, inferred and projected decline based on qualitative assessment of vegetation succession at Alsek meadow.
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[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.	Unknown
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. No b. Partially c. No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	7295 km² (minimum, based on 19 known sites, but unlikely to exceed 20,000 km^2)
Index of area of occupancy (IAO) (Always report 2x2 grid value).	76 km² This is a minimum; probably more sites exist that will increase this value, but unlikely to be >500 km²

Is the population “severely fragmented” i.e., 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. No: may meet criterion (b) but not criterion (a) b. Yes
Number of “locations”* (use plausible range to reflect uncertainty if appropriate)	19, based on shrubification of individual sites (this will occur at different rates or not at all among sites)
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Unknown Observed increase since the previous status report reflects increased search effort
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Probably not, at least in the short term. Observed increase since the previous status report reflects increased search effort.
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Unknown
Is there an [observed, inferred, or projected] decline in number of “locations”*?	Unknown
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, inferred, and projected decline in habitat quality at Alsek meadow site; possible at other sites.
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**
Alsek Meadow	109,670-241,200; based on about 67% of counted plants being mature (see Abundance)
Aishihik, 5 km N	48,910-87,370+; based on about 67% of counted plants being mature (see Abundance)
Aishihik	>184
Nordenskiold R., 5 km downstream of Hutshi Lakes	3
Aishihik Lake, W side, N of Lister Creek	72
Isaac Creek, N side	>200
Isaac Creek, 7.5 km S	Unknown
Lister Creek, upper	25
Nordenskiold R, 15 km downstream of Hutshi Lakes	>10

* See Definitions and Abbreviations on COSEWIC website and IUCN (2016) for more information on this term

Hutshi Lakes	>63
Taye Lake, NE end	>100
Moraine Lake	>20
Hutshi Lakes and Nordenskiold R, plateau between	2000-3000
Nordenskiold R, 5 km E of Mt Vowel	>200
Lake Terrace Cr	>400
Lake Terrace Cr, upper	>50
Incised Cr, upper	>12
Stevens Cr, 4 km W	>50
Taye Lake, 5.4 km S	>48
Total	161,833-332,823 – est. 333,000

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 subpopulations or habitats)

Was a threats calculator completed for this species and if so, by whom?

Yes. Participants: Del Meidinger (facilitator), Syd Cannings, Bruce Bennett, Joanna James, Jana Vamosi, Lori Schroeder (consulting botanist), Shawn Taylor (Environment Yukon), Todd Powell (Environment Yukon), Dan Brunton, Michael Jim (Champagne and Aishihik First Nations), Shannon Stotyn (CWS), Danna Leaman

The following threats are all classified as “low impact”:

i. Invasive and problematic species: Invasion of grasslands by exotic plants, unknown effects of bison disturbance (IUCN #8.1, 8.2)
ii. Human intrusions and disturbance: small effects of off-road vehicle use and camping, especially at Alsek meadow (IUCN #6.1)
iii. Climate change and severe weather: projected increase in mean annual temperature and climate moisture deficit leading to habitat shifting and alteration resulting in shrubification and afforestation of grasslands, increased evapotranspiration (IUCN #11)

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada? Canadian endemic	n/a
Is immigration known or possible?	n/a
Would immigrants be adapted to survive in Canada?	n/a
Is there sufficient habitat for immigrants in Canada?	n/a
Are conditions deteriorating in Canada?	n/a
Are conditions for the source (i.e., outside) population deteriorating?	n/a
Is the Canadian population considered to be a sink?	n/a
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species?	No

Status History

COSEWIC: Designated Endangered in November 2011. Status re-examined and designated Special Concern in November 2018.

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Special Concern	Not applicable
Reasons for designation: This small, short-lived perennial mustard species is endemic to the southern Yukon. It has a very restricted distribution limited to well-drained meadows and south-facing slopes. Surveys undertaken since 2011 increased the area of distribution and number of known sites from 3 to 19, and indicate that the population may not undergo extreme fluctuations as previously thought. Present threats include forest encroachment, wildfire, invasive species, and trampling by humans and bison. These threats have the potential to reduce the area of suitable habitat and numbers of potentially unviable subpopulations enough to qualify the species for Threatened status.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Does not meet criteria. The threats assessment suggests a current and future decline in habitat extent and quality; however, the magnitude of decline is uncertain.
Criterion B (Small Distribution Range and Decline or Fluctuation): Does not currently meet criteria. Thresholds are met for Threatened B1 (EOO unlikely to exceed 20,000 km^2) and Endangered B2 (IAO unlikely to exceed 500 km^2), continuing decline in habitat quality is observed and projected, and decline in habitat extent, number of locations and subpopulations, and number of mature individuals are likely based on known threats. However, the population is probably not severely fragmented at present, number of locations exceeds thresholds, and the population does not undergo extreme fluctuations.
Criterion C (Small and Declining Number of Mature Individuals): Does not meet criteria. Estimated population size range and proportion of mature individuals likely exceed thresholds. The threats assessment suggests a future decline; however, the magnitude of the decline is uncertain.
Criterion D (Very Small or Restricted Population): Does not meet criteria. Estimated population size and proportion of mature individuals exceed thresholds for D1. Estimated IAO and number of locations exceed thresholds for D2.
Criterion E (Quantitative Analysis): Not applicable. Analyses have not been done.

PREFACE

Significant new survey and life history information for Yukon Draba has become available since the species was assessed in 2011. Currently, 19 subpopulations are known, a considerable increase from the single subpopulation known in 2011. These sites, although still restricted to a small portion of the southwestern Yukon, are scattered over an area of approximately 7000 km^2.

Evidence from marked plants shows that Yukon Draba is a short-lived perennial, not an annual or biennial. Additionally, detailed monitoring over several years at two sites (Aishihik and Alsek meadows) indicates that the species probably does not exhibit extreme fluctuations in number of mature individuals, as believed earlier. The number of plants that are flowering in a meadow may vary considerably from year to year, but the number of mature plants fluctuates much less dramatically.

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 (2018)

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
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Canada

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

COSEWIC Status Report

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Scientific name: *Draba yukonensis* A.E. Porsild

Synonyms: none

Subspecies, varieties: none

English common name: Yukon Draba, Yukon Whitlow-grass

French common name: Drave du Yukon

Family: Brassicaceae, Mustard Family

Major plant group: Angiosperm – Eudicot flowering plant

Taxonomic History

In 1975, *Draba yukonensis* was recognized and described by A.E. Porsild based on material from two collections (Porsild 1975). The type was collected and first identified as Few-seeded Whitlow-grass (*Draba oligosperma*) by H.M. Raup and L.G. Raup in 1944, but Porsild's subsequent re-examination of the material determined that there were two *Draba* taxa within the original collection. Similarly, Porsild found specimens of *Draba yukonensis* in another collection of Few-seeded Whitlow-grass made by Dr. W. Schofield and H.A. Crum in 1957. In 2005, G. Mulligan found specimens of *Draba yukonensis* in the Agriculture and Agri-Food Canada herbarium (DAO) collected in 1973 by G.W. Douglas and G.G. Douglas. In 2005, Yukon Draba was first identified in the field by P. Caswell and L. Freese (Bennett 2006).

The ITS2 (ribosomal DNA) and rbcL (chloroplast DNA) genes from 19 specimens of Yukon Draba from throughout the Yukon range were sequenced. Results demonstrated that Yukon Draba specimens are consistently separated from other *Draba* species (Kuzmina pers. comm. 2016).

Morphological Description

Yukon Draba is a small, monocarpic herb with small rosettes of basal leaves. Stems are 2-20 cm high, bearing stellate hairs and 1-3 small sessile leaves, and eventually a racemose inflorescence of 5-20 white flowers (Figures 1 and 2). Flowers give rise to short-styled, ovoid or oblong siliques that are 3-5 mm long with short stellate hairs. Basal leaves are lanceolate, acute, 8-10 mm long, and covered on both sides with predominantly simple, rather long, stiff hairs. Leaves are dark bluish-green.

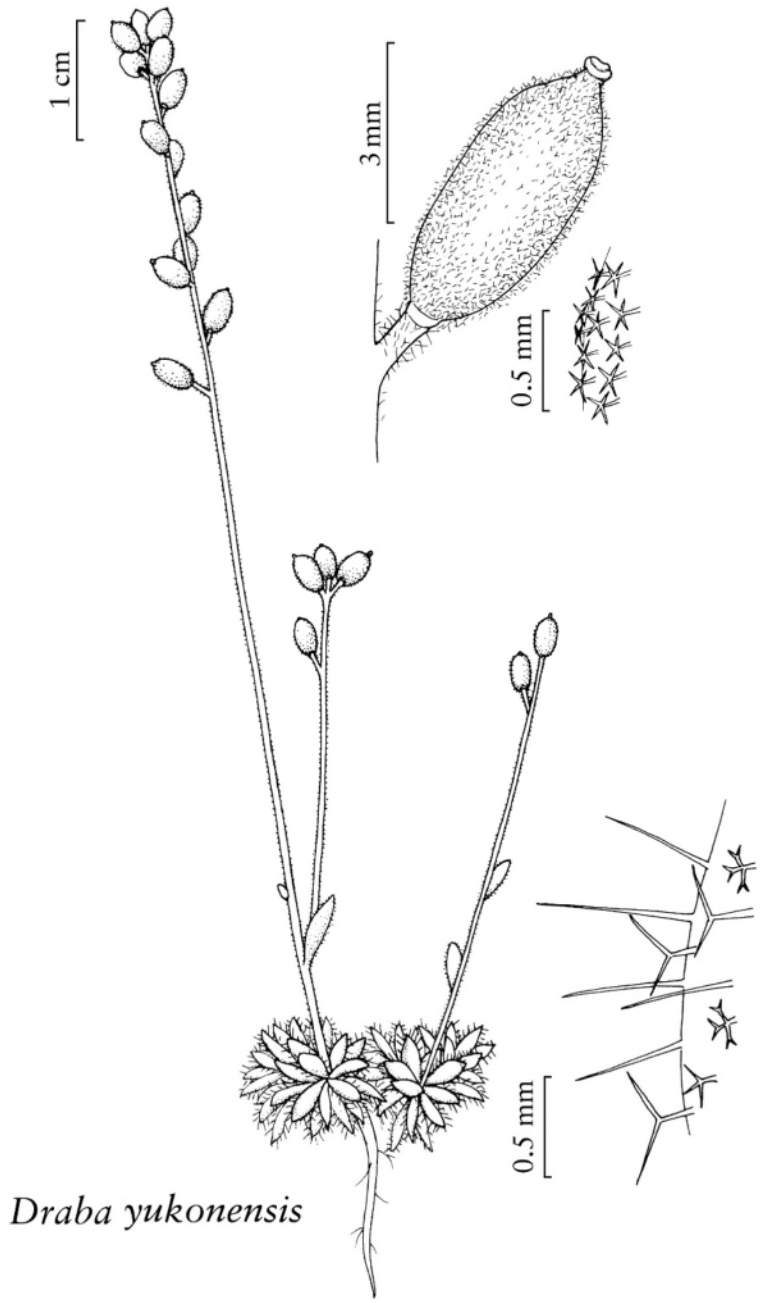

Figure 1. Yukon Draba in fruit. The inset drawing at the top details the external structure of the fruit with a detail of the surface. The inset drawing below shows the abaxial surface of the leaves in detail (artwork courtesy of the Flora of North America Association, illustration by Barbara Alongi, with permission).

Figure 2. Yukon Draba in flower and fruit, Isaac Creek, Yukon, 9 June 2013. Photo: Saleem Dar, with permission.

Individuals may have several rosettes, thus becoming more globose or similar to a "cushion" plant. Each individual has a distinct single taproot.

Yukon Draba is often found in the same meadows as Hoary Draba (*Draba cana*), and is most likely to be confused with that species. However, Hoary Draba has stellate hairs on its leaf surfaces, in contrast with Yukon Draba's predominantly simple hairs. Hoary Draba's lanceolate siliques are noticeably different from Yukon Draba's ovoid ones. With relatively brief experience, one can easily and consistently distinguish the two species in the field by their colour and general appearance, even in the absence of fruit.

Population Spatial Structure and Variability

Although Yukon Draba was distinct from all other *Draba* species in its ITS2 ribosomal DNA sequence (see **Taxonomic History**), no genetic structure was detected among the subpopulations (Kuzmina pers. comm. 2016).

Designatable Units

This species is a narrow endemic, found only at several sites in the southwestern Yukon. No geographic, morphological, or genetic separation is known that would distinguish subpopulations as designatable units.

Special Significance

Yukon Draba, an endemic Canadian species, has a limited distribution that suggests it is a relict associated with the former shorelines of ancient proglacial lakes. The southwestern Yukon is known to be a regional centre of endemism (Bennett pers. comm. 2010; Barrio *et al.* 2013; Williams *et al.* 2016; Sawyer *et al.* 2017).

DISTRIBUTION

Global Range

Yukon Draba is known globally only from the southwestern Yukon, Canada (Figure 3). An occurrence reported in 1981 at the confluence of the Chitina and Copper rivers in southeast Alaska has now been shown to be a misidentification of atypical Hoary Draba (Murray pers. comm. 2010).

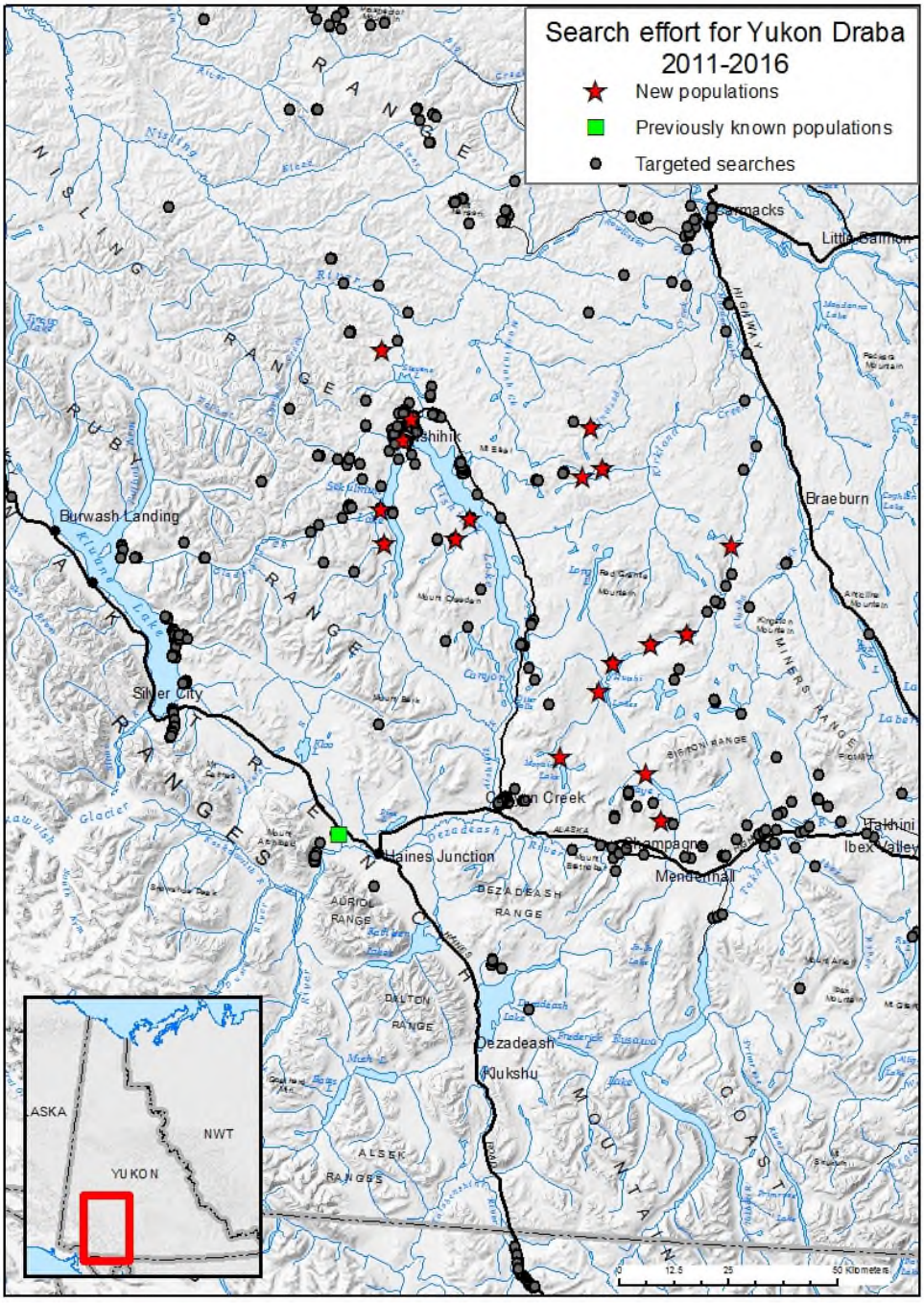

Figure 3. Yukon Draba distribution, including search effort, 2011-2016.

Canadian Range

Yukon Draba is known from 19 sites in the southwestern Yukon, ranging from the Haines Junction area in the southwest, north to Aishihik Lake and the upper Nisling River, and east to Taye Lake and the Nordenskiold River (Figure 3).

Extent of Occurrence and Area of Occupancy

The estimated extent of occurrence (EOO) of Yukon Draba is 7295 km², calculated as the area contained within the shortest continuous boundary around known subpopulations. This area may increase as new subpopulations are found, but is unlikely to exceed 20,000 km^2. The index of area of occupancy (IAO) is a minimum of 76 km², based on a 2 km x 2 km grid laid over the known sites. This area may increase as new subpopulations are found, but is unlikely to exceed 500 km^2.

Search Effort

Until 2000, little search effort for Yukon Draba was documented; however, in 1981, A.P. Khokhryakov, B.A. Yurtsev, and D.F. Murray collected what they thought was Yukon Draba in southeastern Alaska. Although the specimen was later determined to be Hoary Draba (Murray pers. comm. 2010), it is clear that there was some effort to locate Yukon Draba in Alaska.

From 2000 until 2005, Phil Caswell conducted targeted searches for this species and made extensive collections of *Draba* spp. in the Kluane region (Figure 4), many of these in habitats similar to those of Yukon Draba. He made collections of *Draba* spp. on 74 days during this period. Targeted search effort by various surveyors increased once the species was rediscovered by Caswell and Freese in 2005 (Table 1). In addition, hundreds, perhaps thousands, of collections of *Draba* spp. at all the major herbaria housing Yukon material have been reviewed during comprehensive biosystematics investigations of the genus since the 1970s (Mulligan 1976; Al-Shehbaz and Mulligan 2013) and as part of the Flora of North America Project (Al Shehbaz *et al*. 2010). In 2005, Bruce Bennett and Lloyd Freese collected Yukon Draba at its likely type locality. In 2008, Jennifer Line and Lloyd Freese searched a number of meadows in the Dezadeash Valley and found Yukon Draba at two meadows adjacent to the original collection (Line pers. comm. 2017).

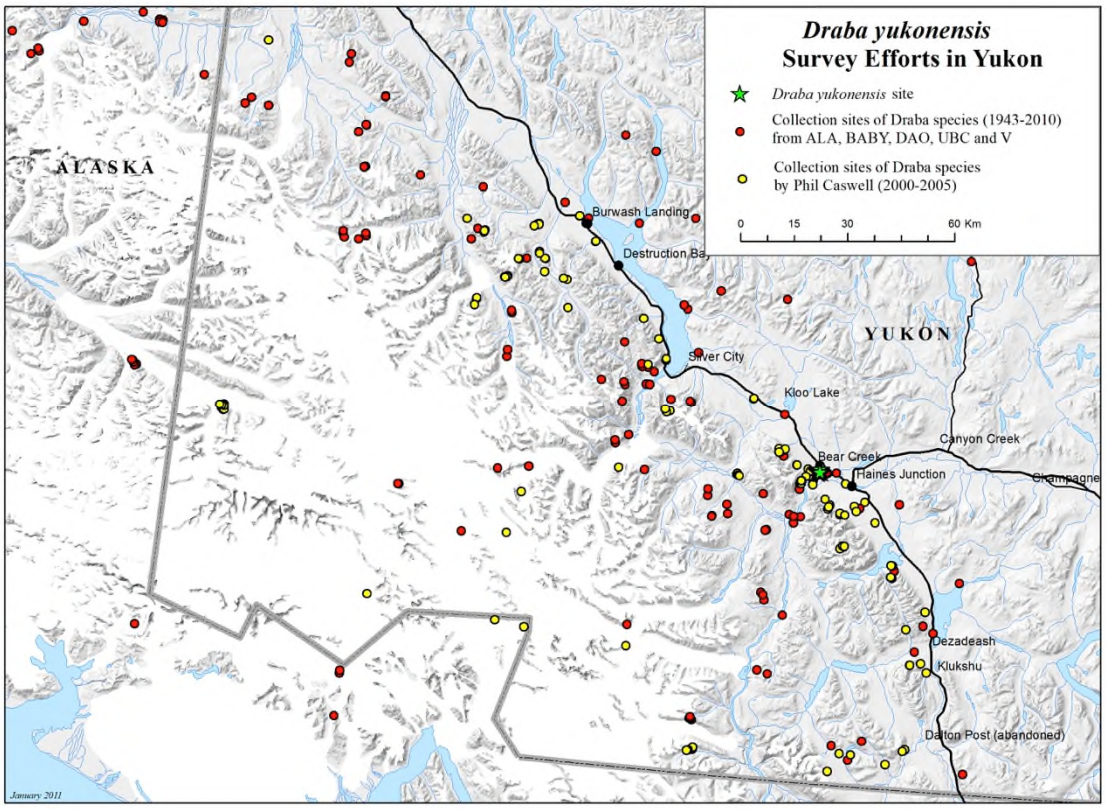

Figure 4. Search effort for *Draba* species in the Kluane region, 1943-2010, including searches by Phil Caswell, 2000-2005.

Table 1. Known sites of Yukon Draba. EO (Element Occurrence) Rank is a measure of viability for occurrences: "A" = excellent viability, through B and C to "D"= not viable, "E"= Extant but viability unknown. Ownership: CAFN = Champagne and Aishihik First Nations.

	Site	# plants	Search effort	Habitat	Elev. (m)	Owner	EO Rank	Threats
1	Alsek meadow (Bear Creek)	150,000-350,000 estimated total 2012-2016	Ongoing monitoring; >> 20 person-days	Flat, dry, well-drained meadows with sparse vegetation	620	Crown	AB	Road improvement; some ATV use, camping; but in YG map reserve. Some gradual vegetation encroachment.
2	Aishihik, 5 km N	363 counted; 45,900 – 56,800 estimated	Moderate: 8+ person-days	Small grassland patches on s-facing slopes of small kettles	960	CAFN	BC	Minor bison trampling, some ATV use
3	Aishihik (open areas	184 counted in	Minimal: 2 person-days	Top and bottom of	940-970	CAFN	BC	Bison trampling, some ATV use

	Site	# plants	Search effort	Habitat	Elev. (m)	Owner	EO Rank	Threats
	immediately W of Aishihik village)	10 patches; probably much higher		steep S- to W-facing grass slopes				
4	Nordenskiold R, 5 km downstream of Hutshi Lks	3 counted	Minimal: 4 person-hours	Flat, dry, grassy bench above river	744	Crown	E	Largely untouched; some bison grazing; placer mining along a tributary about 5 km upstream
5	Aishihik Lk, W side, N of Lister Cr	172 counted	Minimal: 6 person-hours, but much of habitat searched	Steep, grassy slopes in kettle/esker complex; habitat limited	950-1000	Crown	BC	Active mining claims < 5 km
6	Isaac Cr, N side	>200 counted	Minimal: 2 person-hours	Narrow, linear top of grassland/sage slope; limited	975	Crown	BC	Some bison use; habitat limiting
7	Isaac Cr, 7.5 km S	“a few” counted	Minimal: 3 person-hours; only a small portion of potential habitat checked	Open SSW-facing slope in subalpine zone; a number of similar slopes in vicinity	1313	Crown	CD	Negligible
8	Lister Cr, upper	~25 plants	Minimal: 3 person-hours	Steep, grassy SW-facing slope	1070	Crown	C	Negligible
9	Nordenskiold R, 15 km downstream of Hutshi Lks	10 counted	Minimal: 2 person-hours	Complex of small pocket grasslands	730	Crown	E	Expired mining claims nearby (<550 m)
10	Hutshi Lakes	63 counted	Minimal: 50 minutes X 3 people	Flat, grassy meadow on glacial bench	780	Crown	BC	None noted.
11	Taye Lk, NE end	100 counted	Minimal: 1 visit by 3 people	grassland	740 m	CAFN	BC	Extensive bison grazing.
12	Moraine Lk	20	Minimal: 1 visit by 3 people	Grassland slope; crest and midslope	933	Crown	C	Small subpopulation; ingrowth by other vegetation
13	Hutshi Lks and Nordenskiold R, plateau between	2000 to 3000 counted	Minimal: < 1 person-day	Grassland complex.	879	Crown	AB	None apparent.
14	Nordenskiold R, 5 km E of Mt Vowel	200 counted	Minimal: 1 visit by 3 people	Grassland bench	670	CAFN	B?	Small subpopulation with no obvious threats

	Site	# plants	Search effort	Habitat	Elev. (m)	Owner	EO Rank	Threats
15	Lake Terrace Cr	400 counted	Minimal: 1 visit by 2 people	Small grassland	1215	Crown	BC	Within 540 m of active mining claims, and within 420 m of active land application (outfitting).
16	Lake Terrace Cr, upper	50 counted	Minimal: 1 visit by 3 people	Crest of grassland	1274	Crown	B?	No obvious threats
17	Incised Cr, upper	12 counted	Minimal: 1 visit by 3 people	Small grassland	1147	Crown	BC	General area has seen much mineral exploration; active claims < 2km away
18	Stevens Cr, 4 km W	>50 estimated	Minimal: 1 visit by 3 people	Small grassland	1154	Crown	BC	Remote, but within 5 km of active mining claims
19	Taye L. 5.4 km S	48 counted	Minimal: 1 visit by 3 people	Hillside grassland	1200	Crown	BC	None apparent, some nearby bison use documented

In 2011 and 2012, Lori Schroeder sampled 26 vegetation plots in the Aishihik region as part of a study on the effects of bison grazing (Stotyn and Schroeder 2011). These sites are approximately 100 km north and northeast of the Alsek meadow. In 2011, she discovered a single plant adjacent to a plot near the Aishihik airstrip. In 2012, she found two more Yukon Draba sites: one southeast of Aishihik in the Nordenskiold River drainage, 5 km downstream of Hutshi Lakes, and another near the mouth of Lister Creek on the west side of Aishihik Lake (Yukon Conservation Data Centre 2016).

These discoveries prompted Canadian Wildlife Service staff to initiate more extensive surveys in the wider Aishihik and Kluane areas (Figure 3). Over five field seasons (2012-2016) they visited more than 80 sites from Kluane Lake in the southwest, north and northeast to the Dawson Range and Carmacks, and east to Braeburn Lake and the Taye Lake areas. Search effort at each site is detailed in Table 1.

It is likely that more, as-yet undiscovered subpopulations exist, given that: 1) the species is cryptic and easily overlooked; 2) it is patchy in distribution, even in apparently suitable habitats; and 3) its grassland habitat is extensive in southern Yukon, and not all regions have been checked.

HABITAT

Habitat Requirements

Yukon Draba is found in dry, sparse grasslands on well-drained soil at elevations between 611 m and 1313 m a.s.l.

The climate at the type locality ("Alsek Meadow") is subarctic-continental, and is relatively dry as a result of the rain-shadow effect of the St. Elias Mountains immediately to the west. The annual precipitation for Haines Junction averages 305 mm, with half the amount falling as snow. The annual mean temperature is -3^{o} C, and the frost-free period can range from 16 to 86 days per year (Ogden 2006). The Yukon Draba meadows there are situated where the valley enters the St. Elias Mountains; this area is known for strong, cool katabatic winds blowing out of the icefields.

The Aishihik sites are even drier than the Alsek meadows – annual precipitation at the airstrip is only 250 mm, including 95 cm of snow.

Alsek Meadow

Porsild (1975) described the Alsek Meadow locality as "open stony ridges on an ancient beach." The meadows there are dominated by sparse graminoids and herbs, and are surrounded by shrub thickets (predominantly *Salix* spp.), young stands of Trembling Aspen (*Populus tremuloides*), or mature stands of White Spruce (*Picea glauca*) (Figures 5, 6). Unlike other open, herb-dominated plant communities in the area, these meadows do not have a strong southerly aspect, nor are they riparian. Rather, they are almost flat, and appear dry and well drained.

Based on one shallow soil pit dug in 2010, the meadows are underlain by a sandy loam with interspersed gravel. These soils have a veneer of organic matter (~0.5 cm) and a weakly developed humic A horizon (Ah) from 0.5-2 cm in depth (COSEWIC 2011). The lack of better-developed soil horizons indicates that the soil may be classed as a Regosol (Soil Classification Working Group 1998).

At the micro-site scale on these level sites, Yukon Draba is often found in greater densities on the tops of the low ridges, bumps, road berms, and Arctic Ground Squirrel (*Urocitellus parryi*) mounds. This may indicate that it is adapted to drier microsites. However, its apparent absence from south-facing, warm aspects in the general area indicates that it is perhaps intolerant of extremely warm and dry conditions.

These particular meadows are thought to have resulted from a flood event that occurred around 1852 (Clague and Rampton 1982; Schmok and Clarke 1989). Few similar landforms are apparent on satellite imagery (2005) and aerial photography (1996) in the area adjacent to and within Kluane National Park and Reserve (Kluane NPR) beyond the meadow complex.

Aishihik region

The recent discovery of Yukon Draba in the Aishihik region (Figure 3) has broadened the picture regarding its habitat preferences. There, Yukon Draba tends to be found either on moderately sloping, south-facing meadows or at the flat or slightly sloping crests of steeper, south-facing slopes. It is generally absent from the steeper sections of south-facing slopes. The large site near the Aishihik airstrip ("Aishihik, 5 km N") is in glacial kettle terrain (Figure 7). Other sites in that region are along the crests of raised deltas or on other similar postglacial terraces above lakes and streams.

At Aishihik, the meadows are dominated by Narrow-leaved Sedge (*Carex duriuscula*), along with a few other upland sedges in smaller numbers. Also present are Rocky Mountain Fescue (*Festuca saximontana*), Eurasian Junegrass (*Koeleria asiatica*), Glaucous Bluegrass (*Poa glauca*), Pasture Sage (*Artemisia frigida*), Moss Phlox (*Phlox hoodii*), Bluff Cinquefoil (*Potentilla arenosa*), Pennsylvania Cinquefoil (*Potentilla pensylvanica*), Pygmy-flower Rock-Jasmine (*Androsace septentrionalis*), Multi-rayed Goldenrod (*Solidago multiradiata*), and lichens (Figures 7 and 8). Hoary Draba was present in some of the sites (Yukon Conservation Data Centre 2016).

The highest elevation at which Yukon Draba has been encountered is a 1313 m site west of Sekulmun Lake, in the Aishihik region. There, a few scattered plants were growing on a 10 to 15 degree slope with a south-southwest aspect. Other plants on the slope included Hoary Draba, Bluff Cinquefoil, sage (*Artemisia* sp.), sedge (*Carex* sp.), Prairie Pasqueflower (*Anemone patens*), Pygmy-flower Rock-Jasmine, Sweet-flowered Rock-Jasmine (*Androsace chamaejasme*), and Prickly Saxifrage (*Saxifraga tricuspidata*) (Yukon Conservation Data Centre 2016).

Habitat Trends

The Alsek Meadow site has changed little in recent decades, based on descriptions of the area and a photo in Johnson and Raup (1964). However, encroachment of shrubs and trees into the meadows is occurring and may become a threat in the future. The dry and generally cool climate of the region, in conjunction with the well-drained soils, may have impeded succession so that landforms exposed approximately 150 years ago (following the recession of the glacier-induced flood) remain largely free of woody vegetation. However, clones of aspen saplings growing along the fringes of the meadows today indicate slow woody encroachment, particularly in the southern end of the central meadow (Figure 6).

Figure 5. A portion of the Alsek (“Discovery”) Meadow near Haines Junction, Yukon, looking south down the Dezadeash River valley and showing the main road traversing the meadow. The small yellow flowers are Few-seeded Whitlow-grass. Photo: Sam Skinner, with permission.

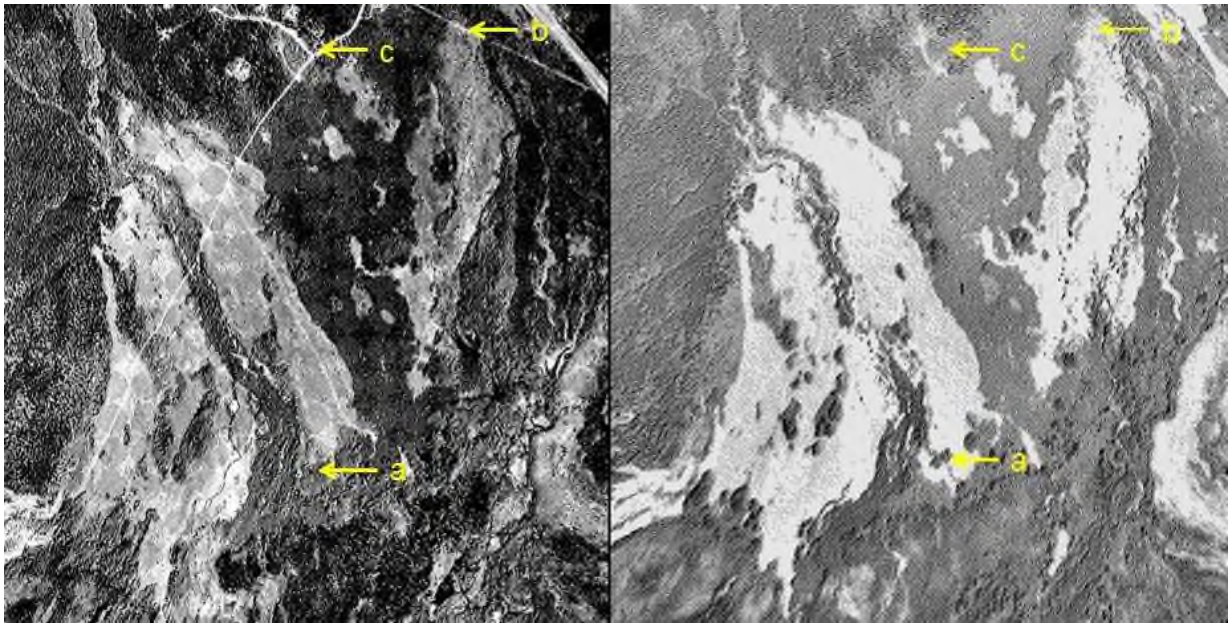

Figure 6. Aerial photos of the Alsek Meadow complex. The image on the left was taken in 1996, while that on the right was taken in 1948. This illustrates the encroachment of woody plants (a), human activities associated with the highway (b), and a small housing subdivision (c).

Figure 7. Yukon Draba habitat in glacial kettle terrain near Aishihik, Yukon. Photo: Syd Cannings.

Figure 8. Close-up of good Yukon Draba habitat, in a 1x1 m plot near Aishihik, Yukon. There are 166 Yukon Draba plants in this plot; the more obvious flowers are Moss Phlox. Photo: Syd Cannings.

Encroachment is also happening at other grasslands in the Kluane and Aishihik regions, especially those on flat terrain (Conway and Danby 2014). This encroachment may be the result of any combination of several factors: natural succession since the land was flooded in the 1850s (in the case of the Alsek Meadow), moister springs, fire suppression, or the recent (post-1990) suppression of Snowshoe Hare (*Lepus americanus*) population peaks in that species' decadal cycles (Hodges *et al*. 2001; Conway and Danby 2014). Arctic Ground Squirrel has also become less common in valley-bottom grasslands in the Kluane area since 2000 (Donker and Krebs 2011), and this change may also increase the survival of new aspen and other woody growth at the edge of grasslands.

Between 1988 and 1992, 170 Wood Bison (*Bison bison athabascae*) were introduced into the Nisling River Valley, north of the Aishihik region (Government of Yukon 2012). The herd now ranges throughout the region and has grown to 1470 individuals, including 1192 mature bison (Jung and Egli 2014). On many of the Yukon Draba sites in the Aishihik and Nordenskiold region, bison footprints and droppings are very apparent, but it isn't clear to what extent the habitat has changed since the arrival of the bison.

BIOLOGY

Very little of the biology of Yukon Draba has been studied directly. However, efforts are underway to grow the species under controlled situations and learn more of its life history (Jones pers. comm. 2017).

Life Cycle and Reproduction

Until recently, little was known about the life cycle of Yukon Draba, and it was variously described as biennial (Cody 1996), a short-lived perennial (Al-Shehbaz *et al*. 2010), and as a winter annual (Bennett pers. comm. 2010 in COSEWIC 2011). To study this aspect of its natural history, a few plants in the Alsek Meadow were collared in 2012 and subsequently re-checked for survival in 2013 (Skinner 2014). In 2013, only about 30% of the plants collared in 2012 had died, indicating that this species is probably not a strict biennial. Additionally, 40% of counted plants in 2012, 46% in 2013, and 30% in 2016 had desiccated racemes from a previous year, which also indicates significant survival into at least a second year and longer (Table 2, Figure 9; Skinner 2014; Canadian Wildlife Service 2017). Cannings (pers. comm. 2018) found and photographed a living plant in 2018 that had been collared in 2012, indicating that it was at least seven years old (Figure 10). These data contrast with the findings reported in COSEWIC (2011) that "roughly one or two plants in 1000 (or 0.1-0.2%) … had a desiccated caudex …, most with signs of dehisced fruit." If almost half the plants are two years old or older, then it is likely that more than half the plants are mature (>/= 1 year) in any given year.

Table 2. Interannual abundance data for Yukon Draba at Alsek Meadow. "Old fruits" refers to plants that show evidence of fruiting in a previous season.

	Transect statistics							Extrapolated Subpop. Size		
	Mean #/ transect all plants	Lower 2.5% CL	Upper 2.5% CL	Mean#/ transect: old fruits	Lower 2.5% CL	Upper 2.5% CL	Prop. old fruits to all plants	Estimate	Lower 2.5% CL	Upper 2.5% CL
2012	14.59	8.28	23.50	5.75	3.03	10.06	0.39	350160	198720	564000
2013	7.22	3.59	14.34	3.34	1.81	6.06	0.46	173280	86160	344160
2016	6.28	3.59	12.09	1.88	0.97	3.53	0.30	163680	86160	290160
2017	13.81	8.66	22.31	3.53	2.06	6.03	0.26	359939	225711	581481

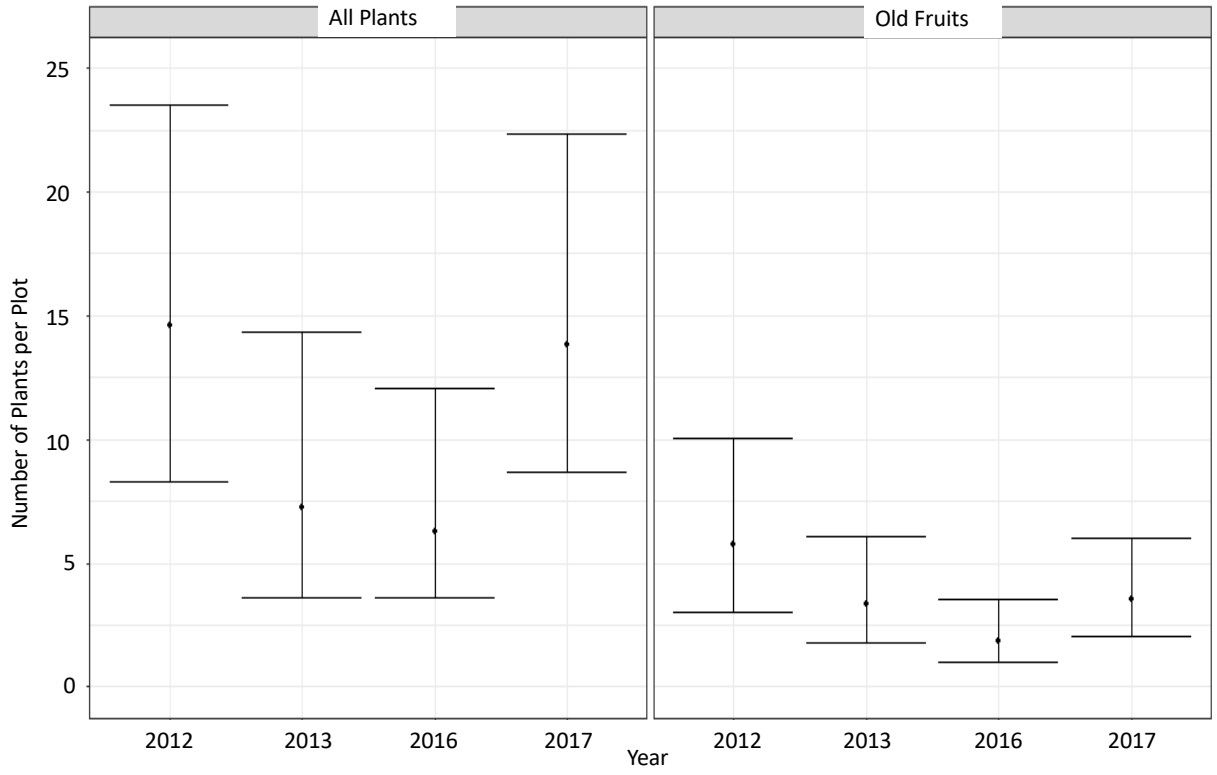

Figure 9. Inter-annual abundance of Yukon Draba at the Alsek Meadow complex, shown as mean number of plants per 50 m x 0.25 m transect (n=30), +95% CI. Raw data from 2012 and 2013 from Skinner (2014); 2016 and 2017 data from Canadian Wildlife Service (2017). Left: numbers of all plants. Right: numbers of plants that showed evidence of fruiting in past season(s).

Figure 10. Yukon Draba tagged in 2012, flowering in Alsek Meadow, Yukon, on 6 June 2018. Photo: Syd Cannings.

At Aishihik in 2016, the story was somewhat different: of 470 randomly counted plants, 164 were “buttons” (presumably germinated that spring or the previous summer, but this total also includes small, older plants that have lost signs of previous blooming), 256 had flower stalks without evidence of previous blooming, 34 had both new flower stalks and old, withered stalks, and 11 had only old, withered stalks (Canadian Wildlife Service 2017). That is, 301 of the 470 plants were mature, but only 45 (9.6%) were in their second (or third) year of blooming.

It therefore appears that Yukon Draba is not a biennial, but is predominantly a short-lived perennial. This interpretation is consistent with the results of earlier survey data (2007-2010) for flowering stems (COSEWIC 2011). Further work on this aspect of Yukon Draba’s life history is continuing. In 2016, plants were marked at both the Alsek Meadow and Aishihik airstrip sites. The fate of these plants will be followed over the next few years to get a better picture of the life history of Yukon Draba.

The pollination biology of Yukon Draba is unknown, although with its inconspicuous hermaphroditic flowers and putative Arctic origins, Yukon Draba likely is able to self-pollinate (Grundt *et al*. 2005). Species in the genus *Draba* typically have genetic mechanisms that prevent hybridization (Skrede *et al.* 2008); no indications of aborted flowers typical of hybrids have been seen (Bennett pers. comm. 2017). No indications of vegetative propagation have been noted.

In the recent past, the subpopulation in the Alsek Meadow has had a distinct biennial flowering cycle, with significantly more blooming in even years. However, this biennial cycle now seems to be less predictable than earlier believed. Additionally, counts suggesting that 97% of the plants were blooming (e.g., in 2010: COSEWIC 2011) may be unreliable, perhaps because non-blooming plants are much harder to detect. In 2016, an even year expected to have high blooming, 50% of plants counted along defined transects were in flower. Although 2017 was expected to be a low blooming year (being an odd year), a surprising 74% of plants were blooming and 2.2 times as many total plants were counted compared with 2016. At Aishihik in 2016, 62% of counted plants were blooming (Canadian Wildlife Service 2017). Estimated generation time (average age of mature individuals in the population) of Yukon Draba is two to three years.

Physiology and Adaptability

Observations of Yukon Draba's habitat associations and life history indicate that it requires full sun, well-drained soils, and is likely intolerant of warmer, steep, south-facing exposures. The Alsek subpopulation, and probably many of the ridgetop grassland subpopulations, is windswept with little snow cover in the winter. This suggests that the species is adapted to extremely cold, dry conditions. In contrast, a portion of the Alsek subpopulation is often covered in overflow ice from a nearby creek in the winter.

Yukon Draba's seed bank may be important for its ongoing survival; however, how long seeds remain viable is untested. Longevity of seeds and seed banking in Yukon Draba are unknown. Yukon Draba seeds do not appear to have complex seed dormancy mechanisms that would influence seed bank development. Work is underway in a laboratory at the University of Guelph, where Yukon Draba seeds recently have been placed in tissue culture; they readily germinated with no pre-treatment (Jones pers. comm. 2017). They are now growing in tissue culture and some plant regeneration has been observed from the roots.

Dispersal and Migration

Little is known about the dispersal ability of Yukon Draba. The seeds are small, without wings or barbs (Al-Shehbaz *et al*. 2010), making them poorly adapted for long-range dispersal. Small mammals may inadvertently transport seeds while feeding on the plant, or when caching fodder. Browsed seed heads of Yukon Draba have been observed (Bennett pers. comm. 2010). It is also likely that the seeds could be transported short distances downhill by surface rainwater. Siliques of other species are known to energetically burst resulting in an active dispersal of seeds (Yano 1997). However, such

a mechanism has not been reported for Yukon Draba. It is also possible that seeds adhering to silique fragments may be dispersed more readily by wind or animals. Given the above, dispersal of seeds between meadows must be infrequent. Little gene flow resulting from pollen movement can be expected, relative to other plant species; however, pollen dispersal can be expected to bridge the divides between meadows, thus resulting in some gene transfer.

Interspecific Interactions

Several instances of herbivory on Yukon Draba have been noted. Whole inflorescences have gone missing between site visits in one season, indicating browsing. Arctic Ground Squirrel and perhaps Meadow-voles (*Microtus* sp.) probably browse these small plants (Jung pers. comm. 2011). This browsing seems to occur during fruit development. While it is clearly detrimental to Yukon Draba, ground squirrel burrows seem to have become loci of higher density of Yukon Draba in the Alsek Meadow. In 2009, a small, black beetle larva was observed feeding on Yukon Draba flowers.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

In the Alsek Meadow, 37 randomly-placed linear plots (50 m long, 25 cm wide) were established in 2012 and counts of all living Yukon Draba plants were made (Skinner 2014). The counts were then extrapolated to all suitable Yukon Draba habitat in the meadows to obtain an estimate of the subpopulation. These transects were again measured in 2013, 2016, and 2017, although some transects could not be found in subsequent years. In total, 32 transects were sampled all four years (Skinner 2014; Canadian Wildlife Service 2017). In 2016 and 2017, the state of each plant was also noted: 1) non-flowering rosettes (presumably in their first year, but perhaps older); 2) flowering stalks; 3) flowering stalks from the previous year(s); and 4) flowering stalks from both present and past years. Because the number of plants per transect was small and often zero, means and confidence limits could not be estimated using parametric statistics; instead, bootstrap confidence intervals were estimated using 1,000,000 bootstrap replicates, implemented with the function “bcanon” from the R package “bootstrap” (Leisch 2015), using the nonparametric BCa (bias-corrected and accelerated) method (Efron and Tibshirani 1993).

At Aishihik, 31 1x1 m random plots were established in 2014 (Cannings 2015), and 31 of these were monitored for four consecutive years 2014-2017 (Canadian Wildlife Service 2017). In 2014 and 2015, all plants were counted without distinguishing ages and maturity. In 2016 and 2017, methods used in the Alsek study were incorporated, and plants were distinguished as outlined above. Similar to the Alsek study, the data were analyzed using bootstrap techniques to generate means and 95% confidence intervals.

Abundance

The estimate of the total population of mature plants ranges from about 162,000 to about 333,000 (see **Technical Summary**).

The largest known subpopulation is at the Alsek Meadow, where estimates of number of plants of all ages range from about 163,000 to about 360,000 (Table 2). In 2016, 67% of all counted plants were considered mature (those with either flowering heads or evidence of past flowering). In 2017, when far more plants were in flower than in 2016, 77% were considered mature. Applying a conservative proportion of 67% to the data from other years to estimate the number of mature plants for the Alsek Meadow, this subpopulation ranges from about 109,200 to 241,200.

The other subpopulation for which estimates have been made through detailed sampling is near the Aishihik airstrip ("Aishihik, 5 km N", Table 3). Estimates there range from about 73,400 to about 130,400 total plants, which means that there were approximately 49,200 to more than 87,350 mature plants, based on an approximate proportion of mature plants of 67% (see above). At Aishihik, the estimated proportion of mature plants ranged from 64% in 2016 to 53% in 2017. The difference between the two years may reflect ability to detect maturity of non-flowering plants. Plants that are small, non-flowering "buttons" were assessed as not mature, but some are probably older plants that have lost the flowering stalks from previous years. Because more plants were flowering (62%) in 2016 than in 2017 (33%), it may have been harder to determine maturity of many of the plants in 2017.

Few of the remaining subpopulations have had serious estimates made, but most are probably much smaller than those sampled.

Table 3. Interannual abundance data for Yukon Draba at Aishihik. Data from 31 1x1 m plots.

	Plot statistics							Extrapolated Subpop. Size		
	Mean #/ plot all plants	Lower 2.5% CL	Upper 2.5% CL	Mean#/ transect: old fruits	Lower 2.5% CL	Upper 2.5% CL	Prop. old fruits to all plants	Estimate	Lower 2.5% CL	Upper 2.5% CL
2014	8.53	4.13	15.50	--	--	--	--	73387	35547	133300
2015	10.23	4.74	25.42	--	--	--	--	87942	40780	218605
2016	15.16	7.25	34.32	1.45	0.45	4.68	0.10	130387	62419	295174
2017	14.65	6.71	31.32	5.39	2.39	14.65	0.37	125948	57703	269374

Fluctuations and Trends

The subpopulation at the Alsek Meadow varied in abundance between 2012 and 2017 by about a factor of two (Table 2, Figure 9). Although it appears that numbers are declining, fluctuations may have occurred in 2014 and 2015 that aren't apparent in the

figure. The proportion of mature individuals may fluctuate less than that of the full population, given that at any one time 30 to 46% of the subpopulation is in its second or greater year (i.e., flowered the previous year; Table 2). The maximum overwinter mortality in these older plants was 50% (Skinner 2014). This mortality may be overestimated because of the difficulty of finding non-blooming plants.

At Aishihik, the number of Yukon Draba plants counted in the 31 1x1 m plots increased from year to year in 2014-16, but dropped slightly in 2017 (Table 3, Figure 11). If these counts are extrapolated to the complete area of the meadow complex (approximately 8600 m^2), estimates of the total subpopulation range from a low of 73,000 in 2014 to a high of 130,400 in 2016 (Table 3, Figure 11). These are estimates of all plants, not just mature plants; in 2016, 64% of the plants counted were flowering or had flowered in a previous year, whereas in 2017, 53% showed signs of present or previous flowering (see **Abundance**). Counts of mature plants were not made in 2014 and 2015 (Canadian Wildlife Service 2017). If all counts are adjusted by a factor of 0.67 (taking into account the difficulties of assessing maturity of individuals, see above), this subpopulation of mature plants ranges from 48,910 - 87,368. As at the Alsek Meadow, numbers varied for the Aishihik subpopulations, but only by a factor of two, not a factor of ten (the minimum factor required to meet COSEWIC's criterion for extreme fluctuations in number of mature individuals). These results must be interpreted cautiously, however, because counts are only available for a time span of four years.

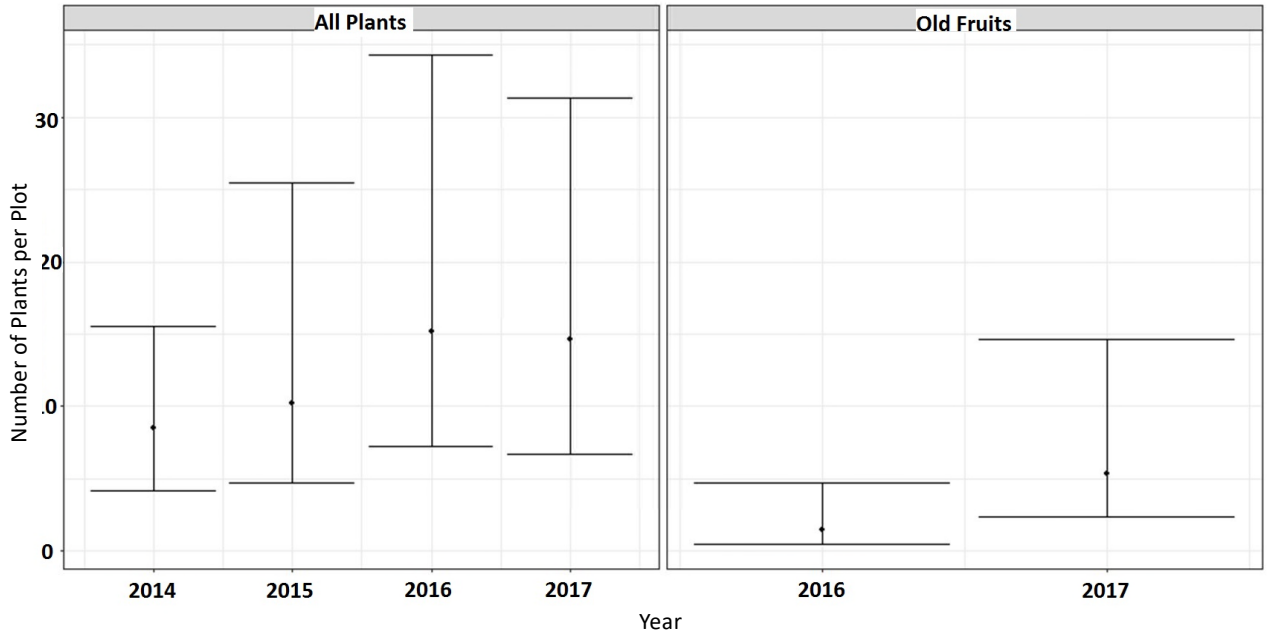

Figure 11. Inter-annual abundance of Yukon Draba at Aishihik meadows, 2014 to 2017 (Canadian Wildlife Service 2017). Abundance is shown as mean number of plants per 1x1 m plot ± 95% CI. Left: Counts of all plants. Right: Counts of plants showing evidence of fruiting in past season(s).

These data contradict the statement in COSEWIC (2011) that the information at hand "supports the hypothesis that *Draba yukonensis* is a biennial, with essentially two temporally separated subpopulations. The larger of these putative subpopulations is approximately fifty times the size of the smaller. The population of *Draba yukonensis* is therefore subject to extreme fluctuations."

To summarize, two large subpopulations have been monitored for four years each, and numbers of all plants and of older plants do vary from year to year, and these variations can be statistically significant. However, over this short period these variations are on the order of about a factor of two, not a factor of ten.

Population Fragmentation

Based on subpopulation size estimates for Yukon Draba, approximately 97% of the total population of mature individuals occurs in just two of the 19 known sites – Alsek Meadow, and Aishihik (Table 1). Of the remaining subpopulations, 10 were estimated to have 100 or fewer mature individuals, although not all of these sites were thoroughly surveyed. Viability of these small populations is uncertain.

Rescue Effect

Because this species is a Canadian endemic, rescue is not possible from populations outside the country.

THREATS AND LIMITING FACTORS

The overall calculated threat impact is LOW-LOW (Appendix 1) because all identified threats were determined to have low, negligible, or unknown impact on species survival. The numbering of threats corresponds to the categories and sub-categories of the threats calculator.

Threat 6: Human intrusions and disturbance – LOW IMPACT

Threat 6.1: Recreational activities (LOW IMPACT)

The Alsek Meadow is used occasionally by campers, especially during the Kluane-Chilkat Bike Relay in mid-June. There is no evidence that camping and occasional all-terrain vehicle (ATV) activities are causing a decline in habitat quality at this time.

Threat 8: Invasive and other problematic species and genes – LOW IMPACT

Threat 8.1: Invasive non-native/alien species (LOW IMPACT)

Sweetclovers (*Melilotus* spp.) have not yet successfully established at Yukon Draba sites, but are a potential threat (Lesica and DeLuca 2000; Spellman and Wurtz 2011). White Sweetclover (*Melilotus albus*) and Smooth Brome (*Bromus inermis*) were found along the Alsek Road in October 2012, and the Yukon government contracted the Yukon Invasive Species Council to undertake a weed pull for these species in July 2013 on and adjacent to the Alsek meadow (McDowell pers. comm. 2013). Sweetclovers and Smooth Brome are common along the nearby (1 km north) Alaska Highway and seeds are easily transported down the Alsek road by vehicles. The more remote sites are not threatened at present.

Common Dandelion (*Taraxacum officinale*) has recently appeared in the Alsek meadow in small numbers and appears to be increasing; it is unknown what effect this species could have on Yukon Draba. Hawkweeds (*Hieracium* spp.), Oxeye Daisy (*Leucanthemum vulgare*) and Yellow Lucerne (*Medicago falcata*) are also future threats.

Threat 8.2: Problematic native species and diseases (UNKNOWN IMPACT)

Between 1986 and 1992, Wood Bison was introduced to the region (Government of Yukon 2012). There is some question about whether Wood Bison is native to the Yukon, but now-extinct Steppe Bison was a major part of the late Pleistocene and early Holocene environment there. Contemporary bison numbers are increasing and as of 2014 stood at approximately 1500 animals (Jung and Egli 2014). Increasing bison numbers in the Aishihik region have resulted in more trampling and grazing. Although trampling, grazing, and browsing may kill individual plants, they also help to keep grasslands open and sparse – characteristics that favour Yukon Draba. Conversely, in some areas, bison droppings cover a significant portion of the grassland.

Threat 11: Climate change and severe weather – LOW IMPACT

Threat 11.1: Habitat shifting and alteration (LOW IMPACT)

Warmer, wetter springs and summers are causing shrubification and afforestation of grasslands. Recent studies in the Kluane and Aishihik areas have shown that encroachment of forest, particularly aspen trees, into grasslands has been nearly ubiquitous on flat terrain and on south-facing slopes over the last 60-80 years. Aspen establishment was positively associated with increased spring temperatures and precipitation (Conway and Danby 2014).

Reduction of suitable habitat is the most likely mechanism of impact on the distribution and population size of Yukon Draba resulting from predicted increases in droughts (Threat 11.2) and temperature extremes (Threat 11.3) related to climate change.

Threats 11.2: Droughts (LOW IMPACT) and 11.3. Temperature Extremes (LOW IMPACT)

Absence of Yukon Draba from south-facing slopes may indicate intolerance to warmer, drier conditions. Annual temperature in the Yukon has increased by 2^{o}C and annual precipitation has increased by 6% since 1950 (Streiker 2016). Although annual precipitation is projected to increase by 10-20% over the next 50 years, projected increase in annual temperature greater than 2^{o}C, combined with longer spring and fall seasons, may result in evapotranspiration increasing more rapidly than precipitation throughout the Yukon (Streiker 2016). Some climate projections predict larger increases in mean annual temperature and severe climate moisture deficits for the known range of Yukon Draba in southwestern Yukon (ClimateWizard 2009; NatureServe 2016). Some character traits of Yukon Draba may increase its vulnerability to climate change effects (Foden and Young 2016; Supplementary Info 1): exposure (its habitat is exposed to climate change impacts), sensitivity (it is habitat-specific), and adaptive capacity (it has poor ability to disperse).

Threat 11.4: Storms and flooding (NOT A THREAT)

Increased summer temperatures may result in more thunderstorms, lightning strikes, and fires. However, an increase in fire frequency may help to keep grasslands open.

Threat 4: Transportation and service corridors – NEGLIGIBLE IMPACT

Threat 4.1: Roads and railroads (NEGLIGIBLE IMPACT)

A dirt road has long traversed the Alsek Meadow, and has been a conduit for foot and vehicular traffic into Kluane National Park and Reserve and to surrounding mining claims and exploration sites. A smaller, two-track road runs the length of the meadow as well, and a shorter, third track has been created to drive around a wet area in the main road. The main road through the meadow, known as the “Alsek Road”, offers four-wheel-drive vehicle, mountain bike and hiking opportunities along the old mining road from the Alaska Highway through the Kluane Game Sanctuary, into the park (Parks Canada 2010). There is no indication that this road has fragmented the population – low berms along the road are home to high densities of Yukon Draba. However, this road resulted in a net loss of habitat.

Visitor use in Kluane NPR near the Alsek meadow Yukon Draba site averages 267 visitors per year (Parks Canada 2010). Habitat disturbance related to this traffic may increase as well. Traffic is therefore expected to increase due to Parks Canada management plan objectives. Parks Canada Agency is drafting a new Management Plan for Kluane NPR, however, so this expectation could change.

In 2011, a mining company owning nearby claims announced plans to upgrade the Alsek Road to facilitate mining operations and provide access to mining properties. After being contacted about the presence of Yukon Draba, the company claimed the remaining land, including portions of the meadow (Figure 5). Road upgrades would greatly increase the size of the road and road standard to allow for industrial development (Solomon Resources Ltd. 2011). If this development proceeds as proposed, road upgrades will have significant impacts on the Alsek Meadow subpopulation. However, the Yukon government signed a security agreement with Longford Exploration Services in 2013 that essentially prohibits mining on these claims (Simpson pers. comm. 2017).

Evidence of salvage logging of large, mature White Spruce killed by the Spruce Bark Beetle (*Dendroctonus rufipennis*) was observed immediately adjacent to the Alsek Meadow. Spruce forest adjacent to the meadows is best accessed by driving over the meadows, which likely involves running over some Yukon Draba plants. Salvage logging of beetle-killed stands for lumber and domestic firewood is likely to continue.

Threat 7: Natural system modifications – NEGLIGIBLE IMPACT

Threat 7.1: Fire and fire suppression (NEGLIGIBLE IMPACT)

Fire suppression may be a factor in tree and shrub encroachment in some Yukon grasslands. However, studies of grasslands in Alaska and southwestern Yukon have emphasized that persistence of xeric conditions, not fire, is the most influential factor in their distribution (Lloyd *et al.* 1994; Vetter 2000).

No studies have been made of the effects of fire suppression in the region. In the Yukon, wild land fire suppression normally occurs only near communities such as Whitehorse, Haines Junction, and Champagne. Although there are no permanent residents in Aishihik, fires would be suppressed in the area because many cabins and other structures are present.

Conversely, climate change may result in an increase in forest fires, both through hotter forests and an increase in lightning. Although fires could kill individual Yukon Draba plants, they could also positively affect Yukon Draba by maintaining open grasslands

Threat 7.3: Other ecosystem modifications (NEGLIGIBLE IMPACT)

There is slow encroachment by poplars and other woody vegetation around the edges of the Alsek meadows. This may be an ongoing event following the proglacial flood in the 1850s (a limiting factor rather than a threat) or it may be a response to wet springs in 1990s. Other sites (e.g., Aishihik) are too dry for woody vegetation encroachment.

Number of Locations

No single threat predominates at all sites. Although the larger sites probably do not face a threat that could cause significant declines over a brief time (e.g., 10 years), the smaller, isolated sites are potentially more vulnerable to any threat causing a decline in number of mature individuals and population viability.

If decline in grassland area through shrubification and afforestation is considered the most serious plausible threat to Yukon Draba subpopulations, there are 19 separate locations, because this threat will act differently at each site.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Yukon Draba currently has no legal protection or status in Canada or the USA. It is not listed under the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (UNEP-WCMC (Comps.) 2015). COSEWIC assessed Yukon Draba as Special Concern in 2018; it was previously assessed as Endangered in 2011. The species has yet to be formally listed under the federal *Species at Risk Act.*

Non-Legal Status and Ranks

Yukon Draba has not been assessed in the IUCN Red List process (IUCN 2016). The Yukon Conservation Data Centre (2016) ranks Yukon Draba as Imperilled-Sensitive (S2S3); because it is a Yukon endemic with a restricted range, the national and global ranks are the same: N2N3 and G2G3 (NatureServe 2015).

Habitat Protection and Ownership

No Yukon Draba occurrences are protected in parks or ecological reserves. The ownership of individual sites is presented in Table 1. Most are on Crown (Commissioner's) Land, but five lie within Settlement Lands of the Champagne and Aishihik First Nations.

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

The report writer wishes to thank to Bruce Bennett, Sam Skinner, Jennifer Line, Lloyd Freese, Saleem Dar, Shannon Stotyn, and Michael Svoboda for their advice, input and field assistance. Lori Schroeder, Ellen Bielawski, David Blakeburn, Karrie Brown, Margaret Campbell, Sarah Davidson, Mike Gill, Lucy Johanson, Nathalie Lowry, Bruce McLean, Jocylyn McDowell, Marty Mossop, Deb Osborne, Steve Osborne, Randi Mulder, Harry Smith, and Shawn Taylor helped in the field as well.

Allan Roberts and Margaret Campbell went out of their way to help with data analyses of the Alsek and Aishihik monitoring results. Maria Kuzmina put Yukon Draba specimens through DNA analysis and helped interpret the results. Special thanks also to Randi Mulder of the Yukon Conservation Data Centre for helping with the data in so many ways.

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- Maria Kuzmina, Plant Lead, Canadian Centre for DNA Barcoding
- Jennifer Line, Botanist, Whitehorse
- Del Meidinger, co-chair COSEWIC Vascular Plant Subcommittee
- Sam Skinner, Botanist, Whitehorse

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BIOGRAPHICAL SUMMARY OF REPORT WRITER

Syd Cannings is a Species at Risk Biologist in the Canadian Wildlife Service in Whitehorse, where he has worked since 2003. He received his MSc in Zoology at the University of British Columbia (UBC) 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

Collections made by Canadian Wildlife personnel from 2011-2016 were identified by Bruce Bennett and confirmed, in some cases, by I.A. Al-Shehbaz. The identities of a number of these collections were also confirmed through DNA barcoding. The specimens currently are held in the personal collection of Bruce Bennett in Whitehorse, Yukon (BABY). Specimens are also held at the University of British Columbia (UBC), Agriculture and Agri-food Canada, (DAO), and the Yukon Government Herbarium, Department of Environment.

Appendix 1. Threats calculator for Yukon Draba (*Draba yukonensis*).

Species Scientific Name	Yukon Draba (*Draba yukonensis*)
Date:	17-05-12
Assessor(s):	Syd Cannings, Del Meidinger (facilitator), Danna Leaman, Bruce Bennett, Joanna James, Jana Vamosi, Lori Schroeder, Shawn Taylor (regional biol, Kluane), Todd Powell, Dan Brunton; Michael Jim; Shannon Stotyn
References:	Draft threats calculator by report writer provided with draft status report discussed and modified during threats conference; basis for calculation of climate change and severe weather impact subsequently modified based on completion of Climate Change Vulnerability Index, discussed with report writer and SSC Co-chairs.

Overall Threat Impact Calculation:		**Level 1 Threat Impact Counts**	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	0	0
C	Medium	0	0
D	Low	3	3
Calculated Overall Threat Impact:		Low	Low

Assigned Overall Threat Impact:	**D = Low**
Impact Adjustment Reasons:	No adjustment necessary.
Overall Threat Comments	**Generation time 2-3 years;** 67% of subpopulation in Alsek meadow - to be considered when thinking about threats. 33% near air strip (conglomeration of meadows). Numbers are low at other locations: these are poorly inventoried, but unlikely to be in 100 k range.

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development						
1.1	Housing & urban areas						
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas						
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						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3.1	Oil & gas drilling						
3.2	Mining & quarrying						
3.3	Renewable energy						
4	Transportation & service corridors		Negligible	Negligible (<1%)	Extreme (71-100%)	High - Moderate	
4.1	Roads & railroads		Negligible	Negligible (<1%)	Extreme (71-100%)	High - Moderate	Only site with threats from road building/widening is the Alsek "Discovery" Meadow. A dirt road cuts across the meadow, current use recreational; some evidence of off-road vehicle traffic to avoid ruts or when road is flooded. Current impacts, including road maintenance, are minor – modestly disturbed road verges are “good” habitat for this species. Upgrades to enable access to industrial development would entail greatly increasing the size of the road. However, widening would likely affect approximately 1% of the total population (ca. 1,500 individuals), and road improvement (e.g., culvert for creek crossing) would likely keep vehicles off the rest of the meadow.
4.2	Utility & service lines						
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use						
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						
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)	Some use of Alsek meadow for camping, ATV use. Regular use currently low but large and may be increasing during annual June bike relay and bluegrass festival. ATV use rare for Aishihik sites - mostly by ground squirrel hunters, who park on the road and walk across the meadows.
6.2	War, civil unrest & military exercises						
6.3	Work & other activities		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Transect and plot count work may crush a few plants.
7	Natural system modifications		Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.1	Fire & fire suppression		Negligible	Large (31-70%)	Negligible (<1%)	High (Continuing)	Fires are infrequent in Alsek region; more frequent in Aishihik region. Fire suppression occurs near communities (i.e., Haines Junction and Aishihik village), but the sites affected are some of the largest occurrences of this species, where fire suppression equipment or fire breaks have potential for impact but currently not large. Some succession is occurring in Yukon grasslands, but only some of this can be attributed to fire suppression. **Persistence of Yukon grasslands is primarily affected by xeric conditions, not fire suppression**. However, recent moister conditions may be enabling shrub encroachment. Succession at Alsek Meadow may be more related to recency of proglacial flood in the 1850s (see 7.3, "Other ecosystem modifications").
7.2	Dams & water management/use						
7.3	Other ecosystem modifications		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Slow encroachment by poplars and other woody vegetation around the edges of the Alsek meadows. This may be an ongoing event following the proglacial flood in the 1850s (a limiting factor rather than a threat) or it may be a response to wet springs in 1990s (climate change?). In either case, a small proportion of individuals (1-10%) in this subpopulation would be affected over 10 years. Other sites (e.g., Aishihik) are too dry for woody vegetation encroachment.
8	Invasive & other problematic species & genes	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	High - Moderate	
8.1	Invasive non-native/alien species/diseases	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	High - Moderate	Invasive sweetclovers are not present right now, but are potential invaders, at least in the long term. What coverage they will have in future is unknown. They grow mostly later in the season, when Yukon Draba plants may have begun to finish their seasonal growth. Introduced species occur around Alsek meadow but not at other sites. Invasive species include Smooth Brome and Common Dandelion; Crested Wheatgrass and other invasives occur further away along the road. Although these are present in small numbers, they present a future threat (>10 years).

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.2	Problematic native species/diseases		Unknown	Restricted (11-30%)	Unknown	High (Continuing)	Introduced Wood Bison range throughout the region and are often seen in Yukon Draba sites, but are essentially absent from the largest subpopulation near Haines Junction. Trampling kills individual plants, but moderate disturbance could help keep meadows open. In some heavily used areas, more than a negligible area of grassland is covered by long-persisting bison droppings. Bison numbers are increasing, but ongoing management will likely reduce the rate of increase. Steppe Bison co-evolved with these grassland species, but past relationship between bison and grassland species abundance is not known. Vascular Plant SSC discussion of initial designation of impact as "negligible" pointed out uncertainty of bison impact and inconsistency with impact designation for Yukon Wild Buckwheat, for which bison impacts are likely similar. Impact has therefore been rated as "unknown".
8.3	Introduced genetic material						
8.4	Problematic species/diseases of unknown origin						
8.5	Viral/prion-induced diseases						
8.6	Diseases of unknown cause						
9	Pollution						
9.1	Domestic & 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						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11	Climate change & severe weather	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Winters colder, drier before 2005; more recent climate warmer and wetter. However, need to be cautious making assumptions about plant habitat requirements based on previous decade if only due to odd weather patterns. Results of analysis using The NatureServe Climate Change Vulnerability Index release 3.0 – Canada (NatureServe 2016) indicate species is "moderately vulnerable" to climate change (abundance and/or range extent within geographical area assessed likely to decrease by 2050) based on: A. exposure to climate increase and moisture deficit throughout its range; B. indirect exposure to climate change; and C. sensitivity and adaptive capacity. Average annual temperature in Yukon increased by 2 degrees C over last 50 years, projected to increase by 2-2.5 degrees C over next 50 years (Streiker 2016). Impacts predicted to be "moderate" by 2050 have been adjusted to "slight" over next 10 years (3 generations) for this species.
11.1	Habitat shifting & alteration	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Warmer, wetter springs and summers may cause shrubification and afforestation of grasslands. Recent studies in Kluane and Aishihik areas show that encroachment of forest, particularly aspen trees, into grasslands has been nearly ubiquitous on flat terrain and on south-facing slopes over past 60-80 years. Shrubs and other perennials (e.g., grasses, kinnikinnick) also increasing in grasslands. Aspen establishment positively associated with spring temperatures and precipitation (Conway and Danby 2014). However, increased summer temperatures may result in more thunderstorms and thus an increase in fire frequency (see 7.1 "Fire and fire suppression"), which will help keep grasslands open. Warmer, wetter growing seasons may result in greater future losses of the open, exposed soil habitat inhabited by this species, although steeper, drier sites (e.g., Aishihik) less likely to be affected than flatter sites (e.g., Alsek).

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.2	Droughts	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Absence from south-facing slopes may indicate some intolerance to warmer, drier conditions. Climate moisture deficit projected to increase by 38.87 to >56.68 between 2000 and 2050 over the range of this species (NatureServe 2016). Some character traits of species may increase vulnerability to climate change effects: exposure (habitat is exposed to climate change impacts), sensitivity (habitat specific), adaptive capacity (poor ability to disperse) (Foden and Young 2016). Absence of the species from similar/suitable sites near existing sites suggests poor dispersal is more limiting than habitat specificity/availability.
11.3	Temperature extremes	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Absence from south-facing slopes may indicate intolerance to warmer, drier conditions, indicating a "somewhat increased" sensitivity to changes in historical and physiological thermal niche (NatureServe 2016). Mean annual temperature is projected to increase by 2-2.5 degrees C throughout the Yukon (Streiker 2016) between 2000 and 2050. Over the range of this species temperatures are projected to increase by 1.5-2 degrees C by the 2050s, based on the Nature Conservancy Climate Wizard (2009).
11.4	Storms & flooding		Not a Threat	Pervasive (71-100%)	Neutral or Potential Benefit	High (Continuing)	Highly flammable forest in the area, and increased thunderstorms related to climate warming, may in future result in more frequent fires. These may help to keep grasslands open.
11.5	Other impacts						

Classification of Threats adopted from IUCN-CMP, Salafsky *et al*. (2008).

Supplementary Info 1. Climate Change Vulnerability Analysis for Yukon Draba (*Draba yukonensis*), based on NatureServe (2016). (Available upon request to the COSEWIC Secretariat.)