COSEWIC
Assessment and Status Report

on the

Yukon Draba
Draba yukonensis

in Canada

ENDANGERED
2011

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:

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COSEWIC
Assessment Summary

Assessment Summary – November 2011

Common name
Yukon Draba

Scientific name
Draba yukonensis

Status
Endangered

Reason for designation
This small herbaceous mustard is limited globally to one meadow complex in southwestern Yukon; it is found nowhere else on Earth. The meadow complex is under threat from industrial activities, nearby human habitation, invasive species, and trampling by humans and forest encroachment. Human use of the meadows is projected to increase, and encroachment by woody species due to natural succession is causing suitable habitat to decline.

Occurrence
Yukon

Status history
Designated Endangered in November 2011.

COSEWIC
Executive Summary

Yukon Draba
Draba yukonensis

Wildlife species description and significance

Yukon Draba or Yukon Whitlow-grass (*Draba yukonensis*) 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 which lie on the soil, and one or more flower-bearing stems. The flowers are small, white, and have four petals. Other Draba species in the area, including Hoary Draba, are easily differentiated from *Draba yukonensis*. *Draba yukonensis* is a Canadian endemic with extremely limited distribution on unusual sandy landforms.

Distribution

Draba yukonensis has been found in only three meadows in a single meadow complex in the Dezadeash River valley in southwestern Yukon, despite numerous searches elsewhere. This locality is within the traditional territory of the Champagne and Aishihik First Nations in an area covering less than 36 hectares.

Habitat

Draba yukonensis grows on almost flat, well-drained meadows, and is often most dense on the tops of low ridges, bumps, road berms, and Arctic Ground Squirrel mounds. These meadows fall within the rain-shadow of the St. Elias Mountains and are subject to windy conditions, cold winter temperatures, and only modest amounts of snow and rain. The meadows are on ancient sandy beaches and spits formed by Neoglacial Lake Alsek that was formed by a surging glacier that blocked the Alsek River. The lake is thought to have drained around 1852, leaving behind only a few isolated sandy landforms that still remain free of trees and shrubs. Several similar flooding and draining events in recent millennia are thought to have ensured the continued existence of habitat suitable for *Draba yukonensis*.

Biology

Most aspects of the biology of *Draba yukonensis* are uncertain, though much can be inferred from its habitat and from related species. *Draba yukonensis* appears to be a biennial species that can occasionally survive for more than two years. It also appears to be tolerant of dry conditions and direct sun, but intolerant of warmer conditions of south-facing exposures. The ability of *Draba yukonensis* to disperse via seeds is likely quite limited because it lacks any obvious adaptations promoting long-distance seed dispersal. Damage from small mammal and insect herbivory has been observed.

Population sizes and trends

There is only one known population of *Draba yukonensis* at the type locality and it is divided unevenly among three adjacent meadows. While these meadows are surrounded by a small number of similar meadows, dispersal to them has not been detected. Limitations in dispersal and habitat availability make the establishment of new sites unlikely.

The population size is subject to extreme fluctuations and may oscillate on a two-year cycle, with even years tending to have more individuals than odd years. Only 109 individuals were counted in 2009, while 5358 were counted in 2010 in a subset of the inhabited meadows. The total 2010 population was estimated to be between 32,500 and 88,200 individuals. Better information on population size and trends is needed.

Threats and limiting factors

Several risks threaten this population, including expanding roads to access mineral claims, increased traffic through the meadows for mining, logging or recreation, gravel extraction, and the potential expansion of an adjacent subdivision. Invasive plant species well adapted to the meadows occupied by *Draba yukonensis* are expanding rapidly in Yukon, and may pose an additional threat. The rarity of suitable habitat within the range of natural dispersal, the restricted range, and extreme population fluctuations are serious limiting factors.

Protection, status, and ranks

Draba yukonensis has no legal protection in Canada. The global, national, and territorial NatureServe ranks are “Critically Imperiled” (G1, N1 and S1 respectively). Though its entire occupied habitat is in the Kluane Wildlife Sanctuary, it is not protected from most human land uses. A small portion of potential habitat is protected in Kluane National Park, but no plants have yet been found in the park despite repeated searches.

TECHNICAL SUMMARY

Draba yukonensis
Yukon Draba Drave du Yukon
Range of occurrence in Canada: Yukon Territory

Demographic Information

Generation time (usually average age of parents in the population)	1-2 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Unknown
Estimated percent of continuing decline in total number of mature individuals within 5 years.	Unknown
Observed percent reduction or increase in total number of mature individuals over the last 10 years.	Unknown
Suspected percent reduction or increase in total number of mature individuals over the next 10 years.	Unknown
Observed percent reduction or increase in total number of mature individuals over any 10 years period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible and understood and ceased?	N/A
Are there extreme fluctuations in number of mature individuals? *However, these fluctuations appear to be a natural result of the biennial lifestyle*.	Yes

Extent and Occupancy Information

Estimated extent of occurrence *Calculated EO = 1.0 km²*	EO =4 km²
Index of area of occupancy (IAO) *Biological area of occupancy = 0.36 km²*	IAO = 4 km²
Is the total population severely fragmented?	No
Number of locations∗	3
Is there an observed continuing decline in extent of occurrence?	No
Is there an observed continuing decline in index of area of occupancy?	No
Is there an observed continuing decline in number of populations?	No
Is there an observed continuing decline in number of locations*?	No
Is there an observed continuing decline in area of habitat?	Yes
Are there extreme fluctuations in number of populations?	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 population)

Population	**N Mature Individuals**
Dezadeash meadow complex – high population year (2010)	32,500 – 88,200
– low population year (2009)	1500 – 2100
Total	N/A

∗ See definition of location.

Quantitative Analysis

Probability of extinction in the wild is at least 10% within 100 years.	Unknown

Threats (actual or imminent, to populations or habitats)

Road construction associated with mining exploration and development, timber harvest and gravel extraction, recreational and industrial traffic, potential subdivision for housing and invasive species.

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? Not present. Endemic to Yukon.	
Is immigration known or possible?	No
Would immigrants be adapted to survive in Canada?	N/A
Is there sufficient habitat for immigrants in Canada?	N/A
Is rescue from outside populations likely?	N/A

Current Status

COSEWIC: Endangered (November 2011)

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Endangered	B1ab(iii)c(iv)+2ab(iii)c(iv)

Reasons for designation: This small herbaceous mustard is limited globally to one meadow complex in southwestern Yukon; it is found nowhere else on Earth. The meadow complex is under threat from industrial activities, nearby human habitation, invasive species, and trampling by humans and forest encroachment. Human use of the meadows is projected to increase, and encroachment by woody species due to natural succession is causing suitable habitat to decline.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals):
Does not meet criterion – declines not documented.

Criterion B (Small Distribution Range and Decline or Fluctuation):
Meets Endangered B1ab(iii)c(iv)+2ab(iii)c(iv) as the EO <5000 km^2, the IAO <500 km^2, there are 3 locations, the habitat is declining and the number of mature individuals undergoes extreme fluctuations.

Criterion C (Small and Declining Number of Mature Individuals):
Does not meet criterion as continuing decline is not documented. However, if continuing decline is inferred or projected, it does meet Endangered under C2a(ii) as during a low year <2500 mature individuals are known and all occur in one population.

Criterion D (Very Small or Restricted Total Population):
Does not meet criteria for D1 as too many individuals are known, but does meet Threatened D2 as it occurs in a very restricted area where all individuals could be affected by a number of human activities.

Criterion E (Quantitative Analysis):
Not done.

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
(2011)

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 Canada | Environnement Canada
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Canada

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

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and classification

Draba yukonensis A.E. Porsild is the only name commonly used for this narrowly endemic plant. It is also known in English as Yukon Draba or Yukon Whitlow-grass (Bennett 2006) and in French as Drave du Yukon (Cannings *et al.* 2005). It is in the family Brassicaceae (mustard family). There are no recognized subspecies, varieties or synonyms.

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 originally collected as *Draba oligosperma* by H.M. Raup and L.G. Raup in June 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 *Draba oligosperma* made by Dr. W. Schofield and H.A. Crum in June 1957. In 2005, G. Mulligan found specimens of *Draba yukonensis* in a collection of Hoary Draba (*Draba cana*) at the Agriculture and Agri-Food Canada herbarium (DAO). This collection was made in 1973 by G.W. Douglas and G.G. Douglas, again prior to the description of *Draba yukonensis*. In 2005, *Draba yukonensis* was first identified in the field by P. Caswell and L. Freese (YT CDC 2010).

Morphological description

Draba yukonensis is a small annual, biennial, or short-lived monocarpic perennial herb with rosettes of lanceolate untoothed leaves 3-10 mm long by 0.5-2 mm wide (Figures 1 and 2). Individuals may have several rosettes thus becoming more globose or similar to a "cushion" plant. In either case, each individual is subtended by a distinct single taproot. Rosettes may bear one or more erect stems 2-20 cm long which in turn bear 1-3 sessile leaves and eventually a racemose inflorescence of 5-20 flowers (Figures 1 and 3). Flowering individuals typically bear 1-3 stems, but more have been observed. Stems often have short lateral flowering branches. Small white flowers with a diameter of <3 mm are composed of four white petals, 1.5-2 × 0.7-0.8 mm. Flowers give rise to short-styled, ovoid or oblong siliques 3-5 mm long with short stellate hairs. Fruits are attached to arched pedicles roughly half the length of the fruit and are terete (i.e. not flattened).

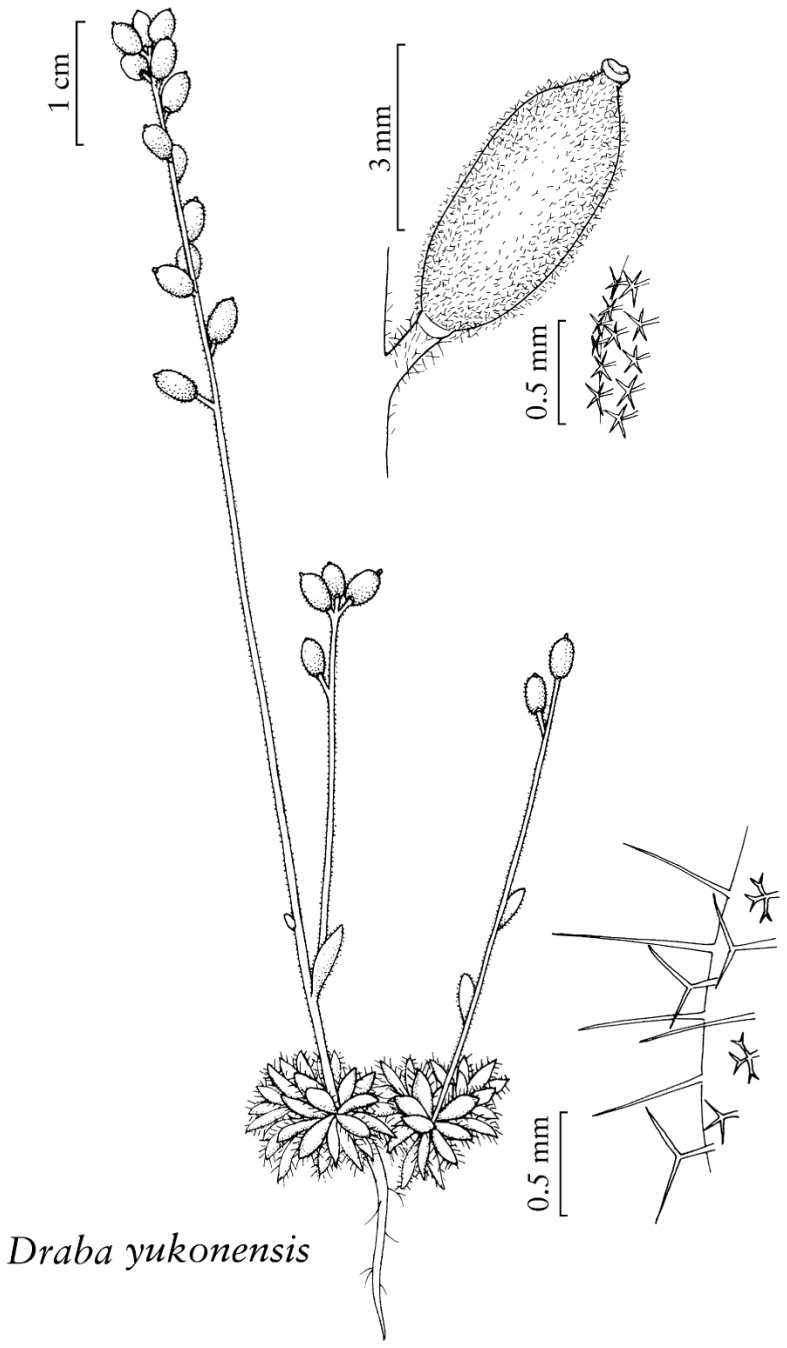

Figure 1. Illustration of *Draba yukonensis* in fruit. The inset drawing at the top details the external structure of the fruit with a detail of the surface. The inset drawing below shows the abaxial surface of the leaves in detail (artwork courtesy of the Flora of North America Association, illustration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

Figure 2. A basal rosette of *Draba yukonensis* surrounded by a “collar” with a diameter of approximately 1 cm. Note the diagnostic long hairs (Skinner 2010).

Figure 3. An individual *Draba yukonensis* plant with several racemes. (Skinner 2010.)

The leaves are covered on both sides with primarily simple, long, stiff hairs (0.4-1.3 mm) which are diagnostic (Figure 2) though some 2-rayed trichomes have been reported (Al-Shehbaz *et al*. 2010). Stems, racemes, and sepals all have simple and multi-rayed trichomes though these are less obviously hairy than the leaves.

In contrast, *Draba cana*, considered by some to be the closest look-alike to *Draba yukonensis*, has predominately stellate (multi-rayed) hairs on the surfaces of the larger, sometimes toothed leaves (Cody 1996). The type description (Porsild 1975) compares *Draba yukonensis* to *D. praealta*, which has creamy yellow flowers and predominantly stellate hairs on the bottom surface of the leaves (Cody 1996).

More detailed morphological descriptions, illustrations, and taxonomic keys are provided by Al-Shehbaz *et al*. (2010) and Cody (1996).

Population spatial structure and variability

The only known population of *Draba yukonensis* is found in three meadows of a single meadow complex . No genetic studies have been conducted on this species.

The life history of *Draba yukonensis* has been speculated to be that of a biennial (see ***Life Cycle and Reproduction***). This, coupled with an apparent biennial oscillation in population size, may indicate that two distinct cohorts of *Draba yukonensis* may flower in alternating years. There is no apparent geographic segregation of these populations. However, roughly one or two plants in 1000 (or 0.1-0.2%) observed in 2010 had a desiccated caudex (i.e., stem), most with signs of dehisced fruit. It is likely that those individuals flowered in two successive years, because no other fresh caudex observed that year was close to dehiscence (Skinner pers. obs. 2010).

Designatable units

Draba yukonensis has been found in only one meadow complex, and can be considered to have only one population. Thus, this population of *Draba yukonensis* comprises a single designatable unit.

Special significance

Draba yukonensis, an endemic Canadian species, has a limited distribution that suggests that it may be a relict species associated with ancient beaches and spits. Several other endemic Canadian plant and animal species are known from this area including *Draba kluanei* and *Oxytropis arctica* var*. murrayi* indicating this is a region of Canadian endemism (Bennett pers. comm. 2010).

DISTRIBUTION

Global range

Draba yukonensis is known from only one locality in southwestern Yukon, Canada (Figure 4). Atypical specimens of *Draba cana* were collected at the confluence of the Chitina and Copper rivers in southeast Alaska by A.P. Khokhryakov, B.A. Yurtsev, and D.F. Murray in 1981. These specimens were mistakenly identified as *Draba yukonensis* (Murray pers. comm. 2010).

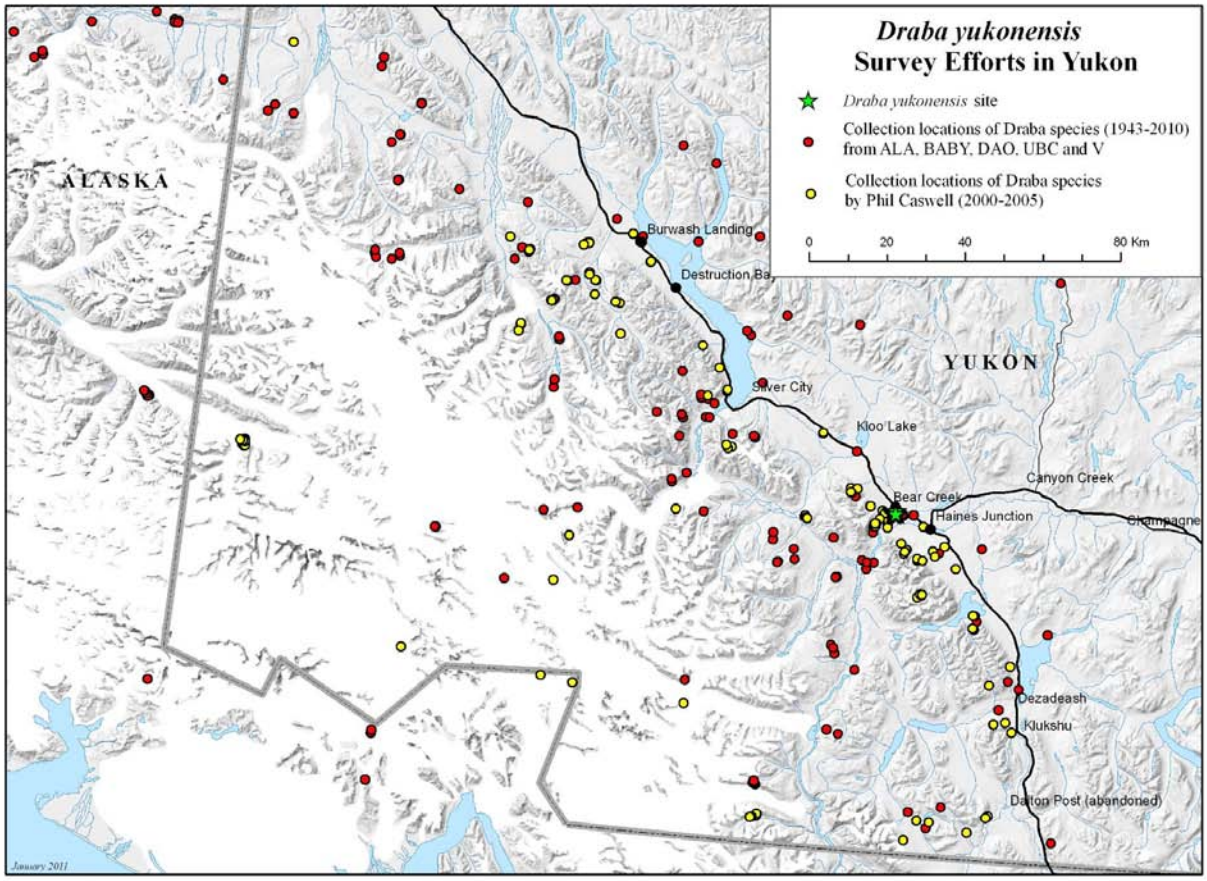

Figure 4. The distribution of *Draba yukonensis* in the context of the southwest corner of Yukon Territory (YT CDC 2010).

Canadian range

Draba yukonensis is endemic to Canada, and is restricted to one meadow complex in the Dezadeash River valley in southwestern Yukon (Figure 4). This complex is in the traditional territory of the Champagne and Aishihik First Nations, and in the St. Elias Mountains Ecoregion, which falls within the Boreal Cordillera Ecozone.

Using collection data from 2010 combined with survey data associated with the element occurrence record of *Draba yukonensis* at the Yukon Conservation Data Centre (YT CDC 2010), the extent of occurrence (EO) was determined to be 1.01 km^2. This extent includes the shrub thickets and wetlands found between the occupied meadows which are inhospitable to *Draba yukonensis*. The estimate of the biological area of occupancy (AO) is 0.36 km^2; however, this is an overestimate of the AO, because it includes small meadows and areas of larger ones where *Draba yukonensis* has not been found. The index area of occupancy (IAO) is 4 km^2 based on a 2 km X 2 km square grid.

In 2005, *Draba yukonensis* was collected by Lloyd Freese and Phil Caswell in the meadow (Figure 5) where it had likely been collected in 1944 (Johnson and Raup 1964), 1957 (Schofield pers. comm. 2005), and 1973. In 2008, the species was collected in two adjacent meadows. This trend of increasing number of occupied meadows is almost certainly due to increased search effort for *Draba yukonensis*, and not due to range expansion.

Figure 5. A portion of the "Original Discovery Meadow" bordered by White Spruce and young Trembling Aspen stands. The Dezadeash River valley is in the background. Note the gravel track crossing the meadow on the right (Skinner 2010).

The distribution of *Draba yukonensis* in the meadow complex is patchy at three scales: 1) local landscape scale (100s of metres); 2) site scale (metres); and 3) microsite scale (10s of centimetres, Figure 5). At the local landscape scale, *Draba yukonensis* is known to occur on three meadows in the complex, despite several other meadows appearing to be very similar to those with *Draba yukonensis*. No individuals were found in one of the presumed extant meadows in 2010. Targeted searches in surrounding meadows in 2006, 2007 and 2008 were equally unsuccessful (Bennett pers. comm. 2010; Figure 4). At the site scale, *Draba yukonensis* can be found in patches of 2-3200 individuals from 50 cm to 40 m across. Patches can be hundreds of metres away from a neighbouring patch with fairly distinct boundaries, or can be immediately adjacent to another patch and be less defined.

Within a patch, *Draba yukonensis* is not strictly specific to any one microsite in the forb- and graminoid-dominated meadows, though it was absent from areas of the meadows dominated by the dwarf shrub Common Bearberry (*Arctostaphylos uva-ursi*). However, the density of individuals seemed to be highest on low ridges, bumps, road berms, and Arctic Ground Squirrel (*Urocitellus parryii*) mounds. These microsite features were seldom raised more than 0.5 m above the meadow.

Despite being patchy, the distribution of *Draba yukonensis* cannot be considered severely fragmented according to the COSEWIC/IUCN definition (IUCN Standards and Petitions Subcommittee 2010). Patches of *Draba yukonensis* at the local landscape level (i.e. individual meadows) in the majority of its area of occupancy are large enough to support a viable population.

Search effort

Prior to its recognition as a species in 1975, there were no targeted searches for *Draba yukonensis*. Nonetheless, individuals were incidentally included in three earlier collections of other *Draba* species. The description and coordinates of these collections all coincide with the known population.

Until 2000, little search effort for *Draba yukonensis* was documented; however, in 1981, A.P. Khokhryakov, B.A. Yurtsev, and D.F. Murray collected what they thought was *Draba yukonensis* in southeastern Alaska. Although it was later determined to be *Draba cana* by Brassicaceae authority R. Rollins (Murray pers. comm. 2010), it is clear that there was some effort to locate *Draba yukonensis*.

In 2000, the late Phil Caswell, an amateur botanist, began targeted searches for the species. The Yukon Conservation Data Centre (2010) database indicates that Caswell made 384 *Draba* spp. collections between 2000 and 2005. The distribution of these collections gives an indication of the area searched (Figure 4). The extent of his collections is over 22,000 km^2, and many of these appear to have been in habitats similar to that of *Draba yukonensis*. Although it isn't known how many days Caswell searched for *Draba yukonensis*, he made collections of *Draba* spp. on 74 days in 2000 and 2002-2005. Targeted search effort increased by various surveyors once *Draba yukonensis* was rediscovered by Caswell and Freese in 2005 (Table 1). In addition, hundreds of collections of *Draba* spp. at all the major herbaria housing Yukon material (Table 2) have been reviewed both by Bennett (pers. comm. 2010) and others as part of the Flora of North America Project. No additional collections have been found.

Table 1. Estimates of search effort in time and extent, and initials of surveyors.

Year	Min. est. search effort (by p/d)	Surveyors' initials (est. p/d)	Original discovery meadow	Middle meadow	Eastern meadow	Other sites	Total surveyed area (km^2)
2000	17	PC	NYD	NYD	NYD	See Figure 4	
2001	0						
2002	24	PC	NYD	NYD	NYD	See Figure 4	
2003	14	PC	NYD	NYD	NYD	See Figure 4	
2004	11	PC	NYD	NYD	NYD	See Figure 4	
2005	9	PC (8), LF (1)	yes	NYD	NYD	See Figure 4	
2006	7	JL (2), LS (2), GM, BB, +1	yes	NYD	NYD	KNP	0.11
2007	2	JL, LF	yes	no	no	AM	
2008	4	JL, LF, BM, +1	yes	yes	yes	no	0.14
2009	2.5	JL, WN, LF (0.5)	1.5 p/d	1.0 p/d	no	no	0.08
2010	5	SS (1.6), PM (1.4), BB (0.4), RM (0.4), LF (0.6), DO (0.3), LA (0.3)	3 p/d	0.6 p/d	0.4 p/d	AM (~1.5 p/d), KNP (~0.5 p/d)	0.09

NYD= not yet discovered, yes=searched but no indication of effort by meadow, no=not searched, p/d=person-days (~7person/hours), KNP=adjacent meadows in Kluane National Park, AM=meadows adjacent to meadows known to have *Draba yukonensis*, PC=Phil Caswell, LF= Lloyd Freese, LS=Lori Schroeder, GM=Gerry Mussnug, BB=Bruce Bennett, JL=Jen Line, BM=Bruce McLean, WN=Wendy Nixon, PM=Polly Madsen, RM=Randi Mulder, DO=Deb Osbourne, LA=Libby Anderson

Table 2. Major herbaria housing Yukon material that were reviewed by authorities familiar with *Draba yukonensis.*

Herbarium	Acronym	Location
University of Alaska Museum of the North	ALA	Fairbanks, Alaska
University of Alberta	ALTA	Edmonton, Alberta
B. A. Bennett Herbarium	BABY	Whitehorse, Yukon
Canadian Museum of Nature	CAN	Ottawa, Ontario
Agriculture and Agri-Food Canada	DAO	Ottawa, Ontario
University of British Columbia	UBC	Vancouver, British Columbia
Royal British Columbia Museum	V	Victoria, British Columbia

In the years 2006, 2008, 2009 and 2010, surveyors on targeted searches for *Draba yukonensis* used GPSs to record trackfiles, or lines where they went, and took waypoints when clusters, or occurrences, of *Draba yukonensis* were encountered (YT CDC 2010). Generally, one GPS was deployed for each group of 2-4 surveyors; therefore trackfiles showed an approximation of their collective movement. The 2006 trackfiles document effort searching potential habitats, while those of 2008 and 2009 were more restricted to known populations (YT CDC 2010). The 2010 surveys included potential and documented habitats.

Surveyed area (Table 1) was estimated by buffering the trackfiles by 1.25 m per surveyor, to reflect an estimated effective scanning width of 2.5 m. So, if there were four surveyors on one survey, their collective "transect" width would be 4 (surveyors) x 1.25 m (buffer width) x 2 (buffer is applied to both sides of the trackfile) = 10 m wide. This calculation assumes that surveyors walk roughly parallel to one another, over 2.5m apart.

There were several general goals of these searches, including: 1) to determine the extent of occurrence of *Draba yukonensis*; 2) to estimate the population size of *Draba yukonensis*; 3) to survey nearby meadows, particularly those in Kluane National Park, for *Draba yukonensis*; and 4) to better understand the life cycle and ecology of *Draba yukonensis*. As a result of the need to address all these goals, the short and variable flowering period of *Draba yukonensis*, conflicting time commitments, and the use of volunteer searchers, these surveys tended to be fairly short and without rigorous methodology. While these surveys did not always employ linear search patterns and did not estimate detectability (Henderson 2009), they reasonably addressed all their goals with minimal resources. Though our understanding of the range and population size of *Draba yukonensis* would benefit greatly by a rigorous survey, such a survey would be a significant undertaking given the patchy distribution and inconspicuous nature of *Draba yukonensis*.

HABITAT

Habitat requirements

The climate in the Dezadeash Valley of southwestern Yukon, where *Draba yukonensis* is known, ranges from subarctic to continental, and is relatively dry because of the rain-shadow effect of the St. Elias Mountains immediately to the west. The annual precipitation for the town of Haines Junction, 9 km away, is approximately 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 meadows and environs in particular are known for the strong westerly winds blowing out of the mountains.

Porsild (1975) described the type locality as “open stony ridges on an ancient beach”. Although this description gives insight into the unusual nature of *Draba yukonensis*’ habitat, it does not provide a complete description. The meadows where *Draba yukonensis* is found 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*) (Figure 5). Unlike other open, herb-dominated plant communities in the general area, these meadows have neither a strong southerly aspect, nor are riparian. Rather, the meadows 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 weakly developed humic A horizon (Ah) from 0.5-2 cm in depth. The lack of better developed soil horizons indicates that the soil may be classed as a regosol (Soil Classification Working Group 1998). These meadows have also been described as dry prairies on old gravel and sand beaches (Johnson and Raup 1964), and are likely to have low nutrient availability.

At the micro-site level, *Draba yukonensis* is often found in greater densities on the tops of the low ridges, bumps, road berms, and Arctic Ground Squirrel mounds. This may indicate that it is adapted to drier microsites. However, its apparent absence from south-facing warm aspects in the general area may indicate that *Draba yukonensis* has an unusual characteristic of being tolerant of dry, well-drained soils, wind, and direct sun, yet intolerant of warmer sites.

These meadows in particular are thought to have resulted from a flooding event that occurred sometime 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 beyond the meadow complex.

Habitat trends

The meadows hosting *Draba yukonensis* have changed little in recent decades, based on descriptions of the area and a photo in Johnson and Raup (1964). However, the encroachment of shrubs and trees into the meadows occupied by *Draba yukonensis* is continuing and may become a future threat. 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 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).

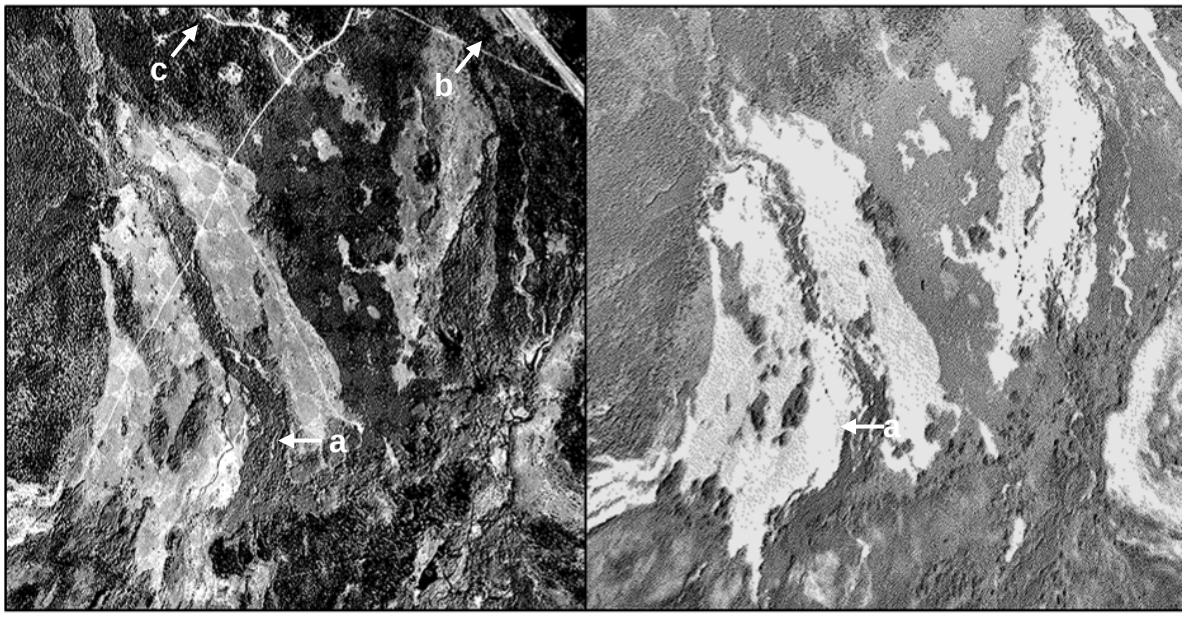

Figure 6. Aerial photos of much of the meadow complex. The image on the left was taken in 1996, while that on the right was taken in 1948. This illustrates the encroachment of woody plants (a) and human activities associated with the highway (b) and a small housing subdivision (c).

A dirt road has long traversed the “Original Discovery Meadow”, and has been a conduit for foot and vehicular traffic into Kluane National Park and to surrounding mining claims and exploration sites. There has been an increase in day visitation to Kluane Park and, in contrast to dropping overnight numbers, day use is up substantially (Parks Canada 2010). Habitat disturbance related to this traffic may increase as well. The 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). Traffic is therefore expected to increase due to Parks Canada management plan objectives. There is no indication that this road has fragmented the population—indeed, low berms along the road are home to high densities of *Draba yukonensis*. However, this road resulted in a net loss of habitat.

BIOLOGY

There have been virtually no publications describing the biology of *Draba yukonensis*. The following notes are derived from field notes and reports, records of discussions with researchers, and publications describing the genus *Draba* in general.

Life cycle and reproduction

Draba yukonensis has been described as biennial (Cody 1996), a short-lived perennial (Al-Shehbaz *et al*. 2010), and as a winter annual (Bennett pers. comm. 2010). No studies have yet definitively determined which term best describes the life history of *Draba yukonensis*. One transplanted plant flowered, produced seed, and died, though it isn't clear if the death was due to stress related to the propagation. Attempts to germinate the seeds have failed (McIntyre pers. comm. 2006). In 2009, large pins were placed within 3 cm of three individuals in an attempt to determine if individuals survive the winter. Unfortunately, in 2010, several plants were found next to one of the pins—it was not clear which one if any overwintered. Snug-fitting collars deployed in 2010 may lead to some insight in 2011 (Figures 2 and 3).

The number of *Draba yukonensis* plants counted per unit of effort has greatly fluctuated year-to-year (Figure 7). Some variation may be explained by the proportion of effort spent enumerating populated habitats versus surveying potential habitats. For example, this survey proportion was skewed toward populated habitats in 2008 compared to 2010, which partly explains the higher success in 2008. Conversely, the survey proportion is comparable between 2008 and 2009. In this case, the number of *Draba yukonensis* plants per unit of effort was considerably higher in 2008. This pattern of populations on even-numbered years being higher corroborates the informal observation by surveyors who had visited the meadow complex over several years (Bennett pers. comm. 2010), and is suggestive of a biennial life cycle, with different-sized cohorts in alternating years. However, 2006 and 2010, both even years, had comparable survey proportions, yet had vastly different counts.

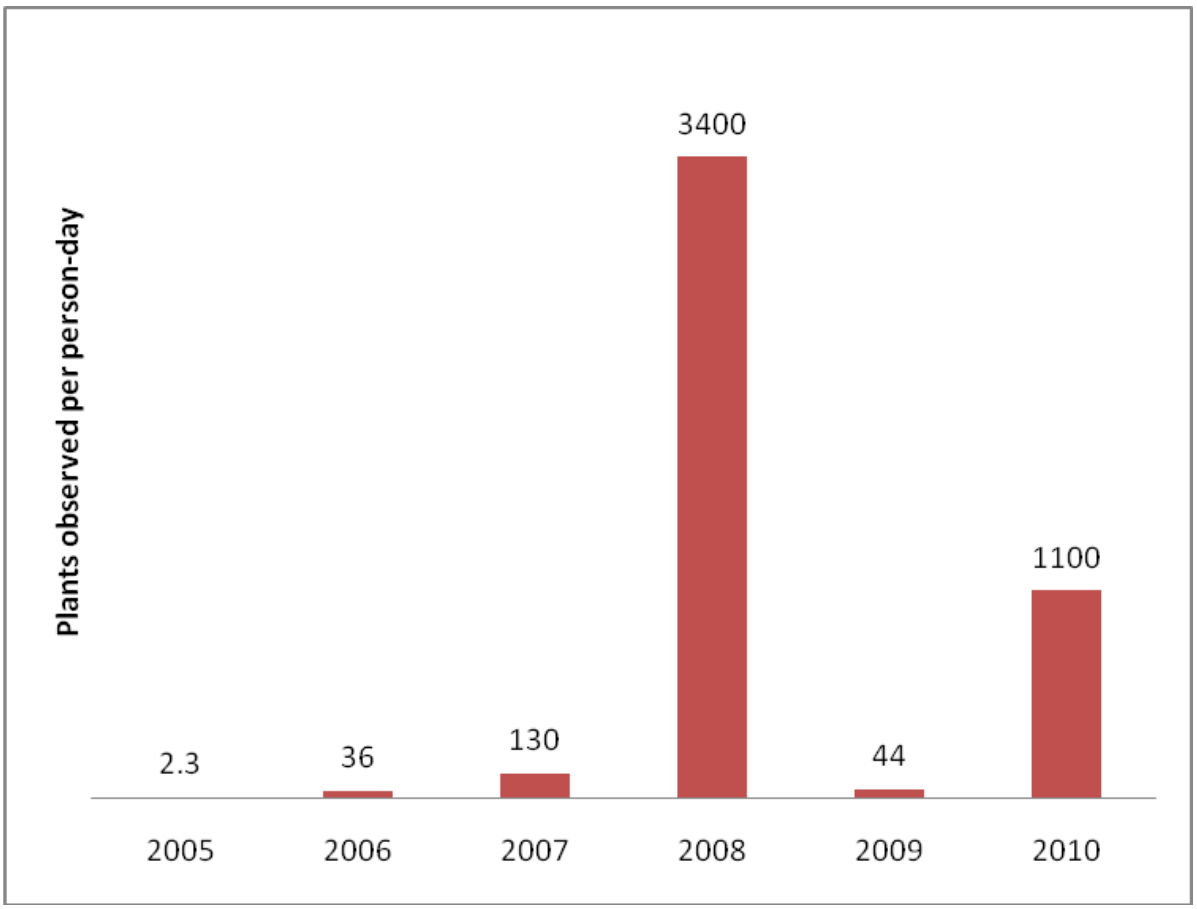

Figure 7. Number of *Draba yukonensis* plants per unit of effort 2005-2010.

Given that the population seems to greatly fluctuate year-to-year (Figure 7), it seems unlikely to be a short-lived perennial. Further, only a small fraction of individuals observed in 2009 and 2010 bore desiccated stems from previous year's flowering, indicating that *Draba yukonensis* may only infrequently and opportunistically adopt a perennial life cycle. It is unknown whether this is a species that relies on the seed bank or the longevity of its seed bank.

A subset of the 2010 observations noted flowering status. Of these, 97% of individuals were flowering. This observation is consistent with a winter annual life cycle, or a biennial life cycle with delayed germination. However, it doesn't disprove a perennial life cycle because non-flowering individuals likely were much harder to detect. On balance, observations imply that the life history may best be described as biennial/opportunistic perennial and thus the estimated generation time is 1-2 years. However, the lack of consistent patterns indicates that more studies of the population dynamics of *Draba yukonensis* are needed.

The pollination biology of *Draba yukonensis* is unknown, though with its inconspicuous hermaphroditic flowers and putative arctic origins, *Draba yukonensis* 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 vegetative propagation have been noted.

Physiology and adaptability

Observations of *Draba yukonensis*' habitat associations and life history indicate that it requires full sun, well-drained soils, and is likely intolerant of warmer south-facing exposures. It is possible that its overwinter survival requires a snow pack for protection from desiccation and extremely low temperatures. Theoretically, it should be well suited for colonizing sandy landforms exposed by changing hydrology, though it isn't clear how or if it can cope with flooding. Wildfire is infrequent in the general area, and unlikely in the meadow habitat of *Draba yukonensis*.

One transplantation and seeding trial was not successful (McIntyre 2006); however, horticultural cultivation and experimental seeding of adjacent meadows may still be possible. Seed collection should be limited to high population years (typically even-numbered years).

Dispersal and migration

Little is known about the dispersal ability of *Draba yukonensis*. 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 *Draba yukonensis* have been observed (Bennett pers. comm. 2010). 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 *Draba yukonensis*. It is also possible that seeds adhering to silique fragments may be dispersed more readily by wind or animal. 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. Longevity of seeds and seed banking of *Draba yukonensis* are unknown.

Interspecific interactions

Several instances of herbivory on *Draba yukonensis* have been noted. Whole inflorescences have gone missing between site visits in one season, thus indicating browsing. Burrows of Arctic Ground Squirrels are found in the meadow complex, though many appear not to be active. Browsing is therefore attributed not only to ground squirrels but also to some other small mammal. Vole (*Microtus* sp.) latrines have been observed in the meadow (Jung pers. comm. 2011) and these voles may also feed on *Draba yukonensis*. This browsing seems to occur during fruit development. While it is clearly detrimental to *Draba yukonensis*, ground squirrel burrows seem to have become loci of higher density of *Draba yukonensis*. No direct observations of herbivory by mammals have been reported; however, in 2009, a small, black beetle larva was observed feeding on *Draba yukonensis* flowers.

With likely limited seed dispersal, pollen dispersal by insects and wind are likely important mechanisms preventing genetic differentiation.

White Sweetclover (*Melilotus albus*), Lucerne (*Medicago falcata*) and other invasive plant species are expanding along roadsides in Yukon and are found within one kilometre of the meadows. *Draba yukonensis* would have difficulty competing with these species should any become established in the meadow complex. However, no invasive plant species have yet been noted in this complex.

POPULATION SIZES AND TRENDS

Sampling effort and methods

At each occurrence on the 2009 and 2010 surveys, the number of individuals of *Draba yukonensis* was noted. Both flowering and non-flowering plants were counted, though the less-common (about 3%) non-flowering plants were not as easily detected. Occasionally the numbers of individuals of particularly dense or diffuse occurrences were estimated. When individuals were very sparse, and without a distinct patch, the start and end points of a rough line transect were recorded. Sampling methods for 2005, 2006, 2007, and 2008 were similar (YT CDC 2010). The total count per meadow, overall count, and count per unit effort are presented in Table 3.

Table 3. Estimates of targeted search effort in time, number of individuals of *Draba yukonensis* counted, and initials of surveyors. Population estimates are not provided here.

Year	Est. search effort (by person/days) (surveyors initials)	Original discovery meadow	Middle meadow	Eastern meadow	Other aites	Total counted	Total counted per p/d
2000	>=17 p/d (PC)				See Figure 4	0	0
2001	0?					0	N/A
2002	>=24 p/d (PC)				See Figure 4	0	0
2003	>=14 p/d (PC)				See Figure 4	0	0
2004	>=11 p/d (PC)				See Figure 4	0	0
2005	>=8 p/d (PC) >=1 p/d (LF) 0.3 p/d (BB)	21 in 2 sub-populations			See Figure 4	21	2.3
2006	>=7 p/d (JL(2), LS (2), GM,BB, +1 other)	250			0 (KNP)	250	36
2007	>=2 p/d (JL, LF)	<250			0 (AM)	<250	130
2008	~4 p/d (JL, LF, BM, +1 other)	3000	10,000	600		13600	3400
2009	2.5 p/d (JL, WN, LF)	51 (in 1.5 p/d)	58 (in 1.0 p/d)	X		109	44
2010	5 p/d (SS, PM, BB, RM, LF, DO, LA)	~5268 (~2p/d)	90 (2/3 p/d)	0 (~1/3 p/d)	0 (AM ~1.5 p/d), 0 (KNP ~0.5 p/d)	5358	1100

Blank=not yet discovered, X=not surveyed, p/d=person-days (~7person/hours), p/h=person-hours, KNP=adjacent meadows in Kluane National Park, AM=meadows adjacent to meadows known to have *Draba yukonensis*, PC=Phil Caswell, LF= Lloyd Freese, LS=Lori Schroeder, GM=Gerry Mussnug, BB=Bruce Bennett, JL=Jen Line, BM=Bruce McLean, WN=Wendy Nixon, PM=Polly Madsen, RM=Randi Mulder, DO=Deb Osbourne, LA=Libby Anderson, SS=Sam Skinner.

To estimate the 2010 population size, the proportion of the habitat surveyed in 2010 was used to extrapolate the number of uncounted individuals. First, all the meadows in the complex were digitized on Google Earth™ (2010) by interpreting the satellite imagery taken in August 2005. Second, meadows, or portions thereof, outside of the likely 2010 area of occurrence were discarded. This area of occurrence was developed using all the recorded observations of *Draba yukonensis* since 2006 except those found in a small meadow where they were absent in 2010. Meadows where *Draba yukonensis* have never been found were also discarded. Third, because survey effort in 2010 was biased toward areas with known concentrations of *Draba yukonensis*, occupied meadows were stratified into core areas and their periphery. Fourth, the proportion of the core areas that were sampled and the number of individuals counted therein were used to extrapolate the population of the core areas. Similarly, the population of the peripheries of the occupied meadows was estimated. These two estimates were added to find the total 2010 population.

In 2010, one exceptionally large diffuse occurrence was found in the periphery of an occupied meadow just when the survey was ending. Unfortunately, time limitations prevented more detailed surveying, and therefore its size and population were estimated.

By interpreting satellite imagery (2005) and aerial photography (1996), few landforms seemingly suitable to *Draba yukonensis* are apparent in the area around the Dezadeash River and Kluane National Park beyond the meadow complex and most of these appear to have been visited by Phil Caswell or as part of the 2005-2010 *Draba yukonensis* surveys (YT CDC 2010). It is therefore unlikely that there are other populations beyond the meadow complex.

Abundance

In 2010, 5358 individuals of *Draba yukonensis* were counted. However, the actual population size is higher because only a portion (5.8%) of *Draba yukonensis* population was counted. By extrapolating 2010 field data, the total population of *Draba yukonensis* in the spring of 2010 is estimated to be 88,200. The calculation of this extrapolation included data from the large and diffuse occurrence that was insufficiently surveyed. If this one outlying occurrence is not included in the calculations, the total population would be estimated at 32,500. The 2010 population therefore was likely between 32,500 and 88,200.

The extrapolation of the 2010 population assumes a uniform density of individuals of *Draba yukonensis* within each type of area (core and periphery), but takes into consideration the supposed differences in density between these two classes. It also assumes that the delineation of the meadows was accurate and that there are no other populations of *Draba yukonensis*.

The 2010 population estimate is one of the highest on record, based on raw count data (Table 3). Unfortunately, limitations in historical data made a similar extrapolation of the lowest *Draba yukonensis* count (2009) difficult or impossible. However, a simple extrapolation based on how much the 2010 extrapolation expanded the 2010 count put the 2009 population at 1500-2100 individuals.

Fluctuations and trends

Population data are not yet robust enough to indicate any definitive fluctuations or trends; however, a histogram of *Draba yukonensis* counts per person-day over the last six years (Figure 7) indicates that *Draba yukonensis* populations may oscillate, with larger population sizes on even years. Such a biennial oscillation 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 (IUCN Standards and Petitions Subcommittee 2010).

The application of the extreme fluctuation criterion is being used in this case because even though fluctuations are likely part of the plant's life history, those fluctuations are considered to increase the population's intrinsic vulnerability. In the case of the threat being road construction, the inability to detect the plant during surveys would increase the vulnerability. The IUCN has used the criterion in the assessment of other annual or biennial herbs including *Arabis kennedyae* which is also potentially threatened by road construction or widening. Another example is *Anthemis glaberrima*, an endemic to the islets near Crete. The area of occupancy and extent of occurrence are both smaller than 10 km². The populations are stable but as this is an annual species, extreme fluctuations are possible (IUCN 2011).

The overall trend in the *Draba yukonensis* population is impossible to determine given the available data. Though populations may appear to be rising since 2005 (Figure 7), this increase is likely due to more targeted surveys that focused more on enumeration of *Draba yukonensis* than on the discovery of new occurrences. The population is considered to likely be declining due to increasing traffic in the meadow complex and due to the slow encroachment of surrounding vegetation. This inferred decline is expected to continue into the future unless measures are taken to reduce the effects of these ongoing threats.

Rescue effect

Given that the only known population of *Draba yukonensis* is in Canada, no rescue effect is possible.

THREATS AND LIMITING FACTORS

The extreme rarity of suitable habitat within the range of natural dispersal and the limited extent of occurrence are serious limiting factors for *Draba yukonensis*. In addition, several threats are present or potential (Table 4). As the three meadows are affected by more than one threatening event, location is defined by considering the most serious plausible threat which differs between the meadows.

Table 4. Reported threats by site*.

Location	Type	Threat	Scope	Severity	Timing
Discovery meadow	Transportation & service corridors	Roads	restricted	extreme	high
	Energy production & mining	Mining & quarrying	pervasive	extreme	moderate
	Recreational activities	Trampling	large	moderate	high
	Residential development	Housing	restricted	serious	low
	Invasive plants	Invasive plants	unknown	unknown	unknown
	Climate change & severe weather	Habitat shifting	small	slight	high to low
Middle meadow	Energy production & mining	Mining & quarrying	large	extreme	moderate
	Recreational activities	Trampling	small	slight	high
	Residential development	Housing	small	serious	low
	Invasive plants	Invasive plants	unknown	unknown	unknown
	Climate change & severe weather	Habitat shifting	small	slight	high to low
Eastern meadow	Recreational activities	Trampling	small	slight	high
	Residential development	Housing	small	serious	low
	Invasive plants	Invasive plants	unknown	unknown	unknown
	Climate change & severe weather	Habitat shifting	small	slight	high to low

***see BCMOE (2010) for definitions of scope, severity, and timing

Industrial development and exploration

In 2011, a mining company owning nearby claims announced plans to upgrade the road running through the meadow to facilitate mining operations and provide access to mining properties. After being contacted about the presence of Yukon Draba, the company proceeded to claim the remaining land including portions of the meadow (Figure 8). Road upgrades would entail greatly increasing the size of the road and road standard to allow for industrial development (Solomon Resources Ltd. 2011). If this development proceeds as proposed it will have significant impacts on the discovery meadow population.

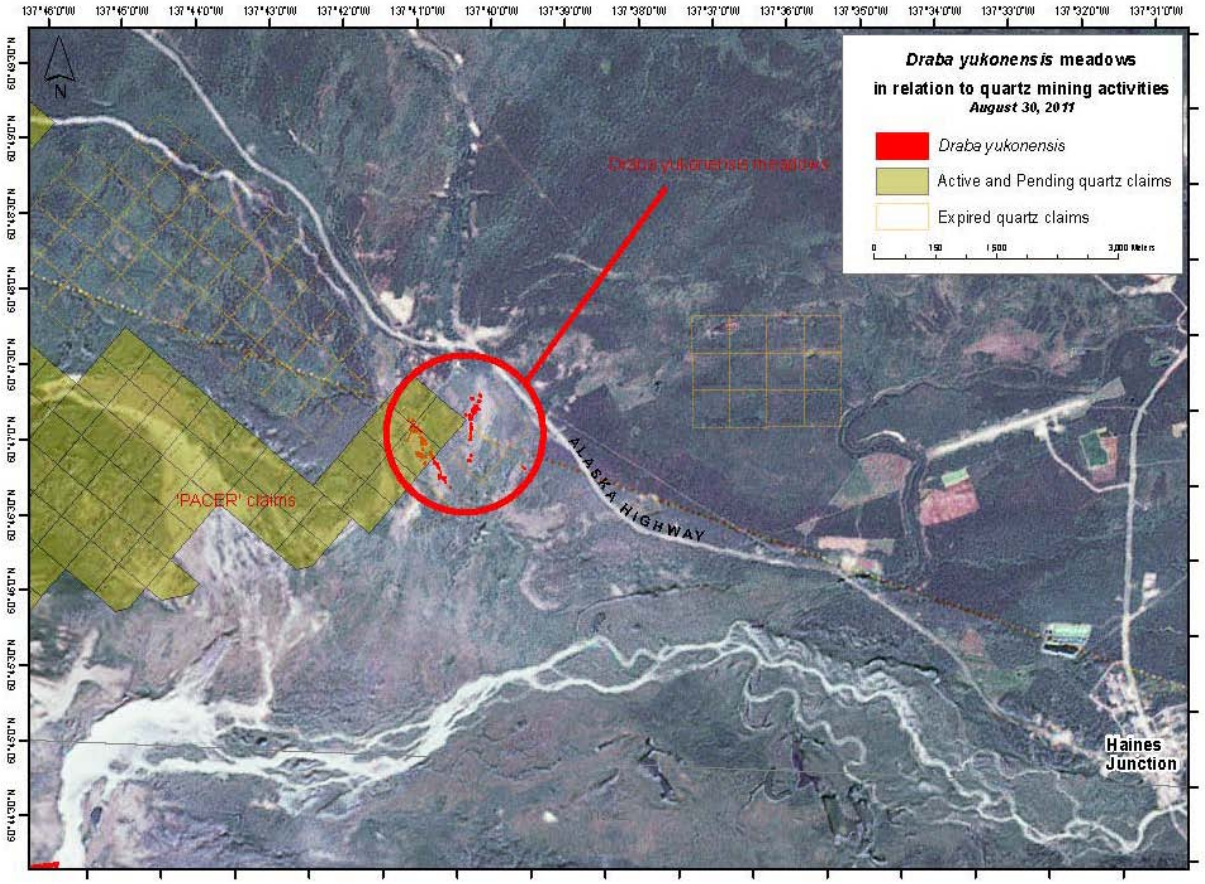

Figure 8. Active and expired mining claims accessed through the *Draba yukonensis* meadows.

The proximity of the meadows to the Alaska Highway and their higher sand and gravel content could make them candidates for gravel extraction.

Transportation and service corridors

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

Residential development

A nearby housing subdivision is in close proximity to the inhabited meadows (Figure 6). The risk of an expansion of this subdivision to the southeast may not be imminent, but would have drastic effects on the habitat and populations of *Draba yukonensis*.

Recreational activities

Between 1948 and 1996, the existing SW-NE road running through a meadow became more ingrained while a new dirt track running north-south through the same meadow came into existence through repeated vehicular traffic (Figures 5 and 6). These roads represent a net loss of *Draba yukonensis* habitat. Expansion of these roads due to informal recreational traffic could lead to further loss of habitat. This was the site of Schofield and Crum's camp when they made the collection in 1957 (Bennett pers. comm. 2010), and more recently is being used as an informal campground during local community events. At times, dozens of tents are erected and vehicles are parked, some likely crush *Draba yukonensis*. Recreational activities of the residents, possibly including ATV riding, may pose risks to populations and habitat.

Trampling likely affects a significant proportion of *Draba yukonensis* habitat or populations but severely impacts only one of the three meadows.

Due to the variety and severity of threat, *Draba yukonensis* may be considered to have 3 locations (IUCN Standards and Petitions Subcommittee 2010).

Invasive plants

Traffic on these roads could introduce invasive plants. White Sweetclover, for example, is well adapted for open well-drained sites, is rapidly spreading along Yukon roads and waterways, and is described as being able to displace or replace native vegetation (Spellman and Wurtz 2011) and change soil nutrient regimes (Lesica and DeLuca 2000). No invasive species have yet been detected in the meadows supporting *Draba yukonensis* so their effects are unknown. Several species are known within 1 km of the meadows including Smooth Brome (*Bromus inermis*), Crested Wheatgrass (*Agropyron cristatum*), Lucerne (*Medicago falcata*) and Alfalfa (*Medicago sativa*) (B.A. Bennett pers. comm. 2010).

PROTECTION, STATUS, AND RANKS

Legal protection and status

Draba yukonensis currently has no legal protection in Canada, and is not listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Non-legal status and ranks

NatureServe's Conservation Status Ranks for *Draba yukonensis* are globally, nationally, and territorially "Critically Imperilled" (G1, N1 and S1 respectively). These rankings were last reviewed on May 31, 2005, after *Draba yukonensis* was rediscovered (NatureServe 2010). It is not assessed by IUCN nor listed on the IUCN Red List. It has a National General Status rank of May Be At Risk (Canadian Endangered Species Conservation Council 2006).

Habitat protection and ownership

The extent of occurrence of *Draba yukonensis* and the majority of the meadow complex falls within the Kluane Wildlife Sanctuary. This designation under the *Yukon Wildlife Act* imposes some restrictions on hunting and animal harvesting, but does not protect plants or habitat from industrial activities and other land uses. There currently are no other designations overlapping the portion of the meadow complex in the Kluane Wildlife Sanctuary (Yukon Government 2010), and there are no processes that are working toward changing the designation of the occupied meadows.

Some outlying meadows, which may provide adequate habitat for *Draba yukonensis*, yet appear not to be occupied, are within Kluane National Park. The present level of protection for habitats occupied by *Draba yukonensis* is insufficient to ensure the long-term survival of this species.

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Authorities consulted

Name	Title	Affiliation	City	Province/Territory
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Cris Guppy	Entomologist	Entomological Society of BC	Dragon Lake	British Columbia
David F. Murray	Professor Emeritus	University of Alaska Fairbanks	Fairbanks	Alaska, USA
Donna Hurlburt	Alternate ATK Subcommittee member	COSEWIC Secretariat / CWS	Annapolis Royal	Nova Scotia
Gilles Seutin	Coordinator for Species at Risk Program	Parks Canada	Gatineau	Quebec
Erich Haber	Chair of Subcommittee for Vascular Plants (COSEWIC)	National Botanical Services	Stittsville	Ontario
Evie Witten	Northern Climate Change Program Director	The Nature Conservancy	Anchorage	Alaska, USA
Gerry Mulligan	Retired Draba expert	DAO Herbarium	Ottawa	Ontario
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Name	Title	Affiliation	City	Province/Territory
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Roger Brown	Forester	Champagne and Aishihik First Nations	Whitehorse	Yukon
Ryan Gould	Geomatics Technician	Geomatics Consultant	Whitehorse	Yukon
Susan Desjardins	Executive Director	Alsek Renewable Resources Council	Haines Junction	Yukon
Syd Cannings	Zoologist	Environment Canada	Whitehorse	Yukon

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