COSEWIC
Assessment and Status Report

on the

Dune Tachinid Fly
Germaria angustata

in Canada

SPECIAL CONCERN
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:

COSEWIC. 2011. COSEWIC assessment and status report on the Dune Tachinid Fly *Germaria angustata* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 43 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Production note:
COSEWIC would like to acknowledge Syd Cannings for writing the status report on the Dune Tachinid Fly, *Germaria angustata*, in Canada, prepared under contract with Environment Canada. This report was overseen and edited by Paul Catling, Co-chair of the COSEWIC Arthropods Specialist Subcommittee.

For additional copies contact:

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

Tel.: 819-953-3215
Fax: 819-994-3684
E-mail: COSEWIC/COSEPAC@ec.gc.ca
http://www.cosewic.gc.ca

Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur la mouche tachinide des dunes (*Germaria angustata*) au Canada.

Cover illustration/photo:
Dune Tachinid Fly — Photos by Shannon Mahony and James O'Hara, Agriculture and Agri-Food Canada; used with permission.

Catalogue No. CW69-14/623-2011E-PDF
ISBN 978-1-100-18673-3

Recycled paper

COSEWIC
Assessment Summary

Assessment Summary – May 2011

Common name
Dune Tachinid Fly

Scientific name
Germaria angustata

Status
Special Concern

Reason for designation
This rare fly is restricted to a very small area of unglaciated Beringia in southwestern Yukon. It is known from 11 largely isolated locations where it occurs in active to semi-stabilized dunes. It is a parasite of the larvae of a dune moth. The threats include a continuing decline in habitat caused by succession on dunes and the use of all-terrain vehicles in some areas which destroy required dune vegetation.

Occurrence
Yukon

Status history
Designated Special Concern in May 2011.

COSEWIC
Executive Summary

Dune Tachinid Fly
Germaria angustata

Wildlife species description and significance

The Dune Tachinid Fly, *Germaria angustata* (Zetterstedt), is a black, bristly, medium-sized fly in the family Tachinidae. The second segment of the antennal branch (arista) is elongated and the third aristomere is flattened side-to-side; these two features give the arista a distinctive, elbowed appearance which helps to identify this species.

This fly is significant in that it represents a group of invertebrate and plant species (a number of which are undescribed scientifically) that, at least in North America, are restricted to active dunes in the southern Yukon.

Distribution

In North America, the known distribution is restricted to 11 locations (14 individual sites) in the southwestern Yukon, from Whitehorse and Carcross west to Kluane National Park and Reserve. In Eurasia, it is rare at European coastal and interior dunes; and is known from a number of localities in Mongolia and adjacent China and Siberia.

Habitat

The Dune Tachind Fly is restricted to active or semi-stabilized dunes or smaller sand blowouts with scattered grasses, sedges, and other vegetation. This habitat preference is probably related to the habitat needs of its likely specific, but as yet unknown host caterpillar. In the Yukon, the known habitat always includes some grass or grasses. The dunes can be in coastal areas with a mesic climate (in Europe) or in interior boreal regions, with a more extreme (cold winter, hot summer) climate.

Biology

Tachinid flies are parasites of the larvae of other insects, often moth larvae. The host of the Dune Tachinid Fly is unknown. Female Dune Tachinid Flies fly low over the open sand, alighting on single stems of grass, walking to the base of each, and apparently depositing an egg there. The eggs undoubtedly hatch into a first instar larva that waits for a host caterpillar to come by. Because of the egg placement at the base of grass or sedge stems, the host of the Dune Tachinid Fly may be a cutworm larva (a moth in the family Noctuidae) that lives underground during the day and comes to the surface at night to feed on the base of the grass. A dune specialist cutworm that is found at Whitehorse and Carcross, and has a very similar global range to that of the Dune Tachinid Fly is the Coast Dart. In the Yukon, adult Dune Tachinid Flies have been collected from 6 June to 23 July; in coastal Europe the flight season is longer, from late May to mid-August.

Population sizes and trends

Appropriate habitat at a site is often limited, and this is a parasitic species dependent on a host moth, so population sizes are probably quite small for an insect. There is no information on population trends. Population size may vary a great deal from year to year, as in other tachinid flies, but there are no data. Although population size and density are difficult to estimate, thirty-minute searches in appropriate habitat result in catches of up to 13 specimens, usually 0 to 7.

Threats and limiting factors

There is no detailed information on limiting factors. The main, proximate limiting factor is probably the distribution and abundance of the Dune Tachinid Fly's host moth. Since the end of the Pleistocene, dune stabilization and vegetation succession has eliminated most of the active dune habitat in the region. While some active dunes appear to be in equilibrium (i.e., new blowouts approximately equal areas stabilized), succession will probably eliminate more open dune area, especially at the large, but relatively young Alsek dunes in Kluane National Park and Reserve.

A potential, but significant threat is invasive species that have the ability to quickly stabilize dunes. Potential threat species include Altai Wild Rye and White Sweet-clover.

At the Carcross dunes, increasing recreational all-terrain vehicle use has caused a decline in habitat by eliminating vegetation and thereby eliminating food plants for host moths.

Protection, status, and ranks

There is no legal protection for this fly in Canada, except for that afforded its populations within Kluane National Park and Reserve and Kusawa Territorial Park.

It has not been ranked by the National General Status program; NatureServe ranks it G4G5 globally; the Yukon Conservation Data Centre ranks it S2 in the Yukon.

TECHNICAL SUMMARY

Germaria angustata
Dune Tachinid Fly — Mouche tachinide des dunes
Range of occurrence in Canada: Yukon Territory

Demographic Information

Generation time (average age of parents in the population)	1 yr
Is there a continuing decline in number of mature individuals? *Unknown; but based on habitat extent and condition, probably a local decline at Carcross; future, longer-term declines can be inferred for the Alsek dunes, which appear to be undergoing stabilization.*	Probable small, continuing decline
Estimated percent of continuing decline in total number of mature individuals within 5 years. *Unknown, but probably a small decline*.	Probable small decline
Estimated percent reduction in total number of mature individuals over the last 10 years. *Unknown; probably has declined somewhat because of habitat reduction at Carcross.*	Probable small decline
Suspected percent reduction in total number of mature individuals over the next 10 years. *Difficult to quantify, but a small decline can be inferred if present habitat trends continue.*	Unknown, but probably a small decline
Estimated percent reduction in total number of mature individuals over any 10 year period, over a time period including both the past and the future. *Difficult to quantify, but a small decline can be inferred if present habitat trends continue.*	Unknown, but probably a small decline
Are the causes of the decline clearly reversible and understood and ceased? *Causes of inferred declines from habitat loss at Carcross are reversible, but not ceased*.	No
Are there extreme fluctuations in number of mature individuals? *Unknown, but this may be the case, based on other tachinid populations.*	Unknown but probable

Extent and Occupancy Information

Estimated extent of occurrence	15,600 km²
Index of area of occupancy (IAO) *Figure given is for 2 km x 2 km grid; actual AO < 2 km²*	48 km²
Is the total population severely fragmented?	No
Number of "locations∗"	11
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy? *Unknown; probably stable at the 2km^2 grid scale, but may be declining at smaller grid scales.*	Unknown
Is there an [observed, inferred, or projected] continuing decline in number of populations? *Unknown, probably relatively stable*	Unknown
Is there an [observed, inferred, or projected] continuing decline in number of locations? *Unknown, probably stable*	Unknown

∗ See definition of location.

Is there an observed, continuing decline in area and quality of habitat*? Destruction of grasses at main Carcross dunes; in the long term, stabilization probably occurring at Alsek and parts of Carcross*	Yes, perhaps about 10% in last 20 years.
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
Whitehorse, 5 km N	Unknown
Whitehorse, bluffs to W	Unknown
Whitehorse, Riverdale	Unknown
Whitehorse, Schwatka L	Unknown
Carcross	Unknown
Takhini River	Unknown
Dezadeash River, Champagne	Unknown
Aishihik Lake, ridge to W	Unknown
Sekulmun Lake	Unknown
Alsek River	Unknown
Slims River	Unknown
Total	Unknown

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	n/a

Threats (actual or imminent, to populations or habitats)

At the large Carcross dunes, all-terrain vehicle use has degraded or eliminated some habitat. Natural succession in the Alsek River dunes is probably slowly reducing habitat there. These kinds of threats do not involve the majority of sites. Another potential but imminent threat is from invasive plants that can stabilize dune habitat

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? *Not yet found in Alaska, but may occur there*. *However, any populations there would be very distant (approx. 1000 km), and short-term immigration rates would be negligible.*	
Is immigration known or possible?	No
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada? *Unknown, but probably not, because available habitat is occupied*.	No
Is rescue from outside populations likely?	**No**

Current Status

COSEWIC: Designated Special Concern in May 2011.

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Special Concern	Not applicable

Reasons for designation:

This rare fly is restricted to a very small area of unglaciated Beringia in southwestern Yukon. It is known from 11 largely isolated locations where it occurs in active to semi-stabilized dunes. It is a parasite of the larvae of a dune moth. The threats include a continuing decline in habitat caused by succession on dunes and the use of all-terrain vehicles in some areas which destroy required dune vegetation.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable as the total number of mature individuals is unknown.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. With an index of area of occupancy (IAO) of 48 km^2, this species is very close to meeting Threatened under B2ab(iii) but there are more than 10 locations (11) and the continuing decline of habitat, based on stabilization (succession) of dunes and ATV use, is localized and unlikely to have a significant impact over the next 10 years.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable as the total number of mature individuals is unknown.
Criterion D (Very Small or Restricted Total Population): Not applicable as the index of area of occupancy (IAO) is greater than 20 km^2 and there are more than 5 locations.
Criterion E (Quantitative Analysis): Not available.

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.

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

COSEWIC Status Report

on the

Dune Tachinid Fly
Germaria angustata

in Canada

2011

TABLE OF CONTENTS

List of Figures

List of Tables

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and classification

Kingdom: Animalia — animals, animaux

Phylum: Arthropoda — arthropods, arthropodes, Artrópode

Subphylum: Hexapoda — hexapods

Class: Insecta — hexapoda, insects, insectes, insectos

Order: Diptera — true flies
Suborder Brachycera — circular-seamed flies, mouches muscoïdes, muscoid flies, short-horned flies

Family: Tachinidae — tachinid flies

Scientific name: *Germaria angustata* (Zetterstedt, 1844) — Dune Tachinid Fly

Synonyms:
Gonia angustata Zetterstedt
Atractochaeta angustata (Zetterstedt)
Atractogonia angustata (Zetterstedt)

Germaria angustata (Zetterstedt) is a true fly (Order Diptera) in the family Tachinidae. The type locality is the Skåne district of Sweden. The genus *Germaria* Robineau-Devoisdy 1830 is a group of 13 species restricted to the Nearctic and Palearctic regions (Ziegler 2010; D.M. Wood, pers. comm. 2009; O'Hara 2008; O'Hara and Wood 2004; Herting and Dely-Draskovits 1993); *G. angustata* is the only member of the genus in the Nearctic region (O'Hara and Wood 2004; Wood 1994). There are no subspecies described. There is no official English name; the name "Dune Tachinid Fly" given here refers to the fact that this species is restricted to active aeolian sand.

Morphological description

Germaria angustata is a shiny black, medium-sized fly, approximately 9 mm long (Figures 1, 2). Like other tachinids, it has long, stout bristles on its head, thorax, and abdomen; and a well-developed, convex subscutellum. Some parts of the body are covered in a waxy pruinosity, creating patterns of blue-grey on the otherwise shiny black surface. The eyes are burgundy in colour. The antennae of tachinid flies have a small branch, the arista, made up of three segments called aristomeres. Although the first aristomere of *G. angustata* is inconspicuous, the second aristomere is elongated and slightly curved (Figure 2). The third aristomere is flattened side-to-side, so that in lateral view it appears to be broader than it does in dorsal view (Figure 2). The robust arista thus has a distinctive, elbowed appearance that is visible with only small magnification, making field identification of the genus relatively easy.

The larva has not been collected or described.

Figure 1. Dorsal (top) and lateral (bottom) views of a male *Germaria angustata* from Carcross, Yukon. Fly is approximately 9 mm long. Photos by Shannon Mahony and James O'Hara, Agriculture and Agri-Food Canada; used with permission.

Figure 2. Close-up of the head of the male *Germaria* in Figure 1, showing the elbowed arista of the antenna. Note the elongated second aristomere and (arrow) the flattened third aristomere. Photo by Shannon Mahony and James O'Hara, Agriculture and Agri-Food Canada; used with permission.

Population spatial structure and variability

Little information is available, but because of their need for active, aeolian sand habitat, and their parasitic dependence on a host moth, populations are isolated and often small. A few, such as those at Carcross, are probably significantly larger than most. There is no information on genetic variability, but Yukon specimens have been submitted to J. Ziegler at the Museum für Naturkunde in Berlin for a study on global genetic variability in this species.

Designatable units

Because all populations are restricted to the southwestern Yukon, and there is no evidence of genetic or morphological variability among populations, there is only one designatable unit.

Special significance

Germaria angustata (and its frequent companion, the Baikal Sedge, *Carex sabulosa* Turcz. ex Kunth) represent a group of invertebrate and plant species (a number of which are scientifically undescribed and unnamed) that, in Canada at least, are restricted to active dunes in the southern Yukon. Other species in this group have not been considered for assessment by COSEWIC partly because they are not described and named, and partly because little is known of their distribution and biology.

They include (Polak 1989; D.M. Wood, pers. comm. 2009):

- *Platycheirus* new species (Diptera: Syrphidae)
- *Coloradomyia* new species (Diptera: Tachinidae; also known from Nogahabara Dunes in Alaska)
- *Exorista* new species (Diptera: Tachinidae)
- *Panzeria* new species (Diptera: Tachinidae).

Gnorimoschema ligulatum Povolny, a gelechiid moth, is described and known only from the Carcross dunes, but this distribution restriction may be the result of undercollecting (Nazari and Landry 2009).

Other dune specialist species in the Yukon dunes have a broader, but still restricted distribution in North America. For example, the tachinid fly *Allophorocera sajanica* Mesnil is known from the dunes at Kusawa in the southern Yukon and the Lake Athabasca dunes in Saskatchewan. Its presumed host, the Kamchatka Crane Fly, *Tipula kamchatkensis* Alexander, is known from the Yukon dunes, the Athabasca dunes, and a few dunes in the Northwest Territories (Polak 1989). *Gnorimoschema vastifica* Braun, a gelechiid moth, is the most common species of its genus in the Yukon dunes, and is also found in dunes in Alberta, Saskatchewan, and Alaska (Nazari and Landry 2009).

DISTRIBUTION

Global range

In Eurasia, *G. angustata* is found in two distinct areas—Europe, and a part of central Asia, centred on Mongolia and including adjacent northern China and southern Siberia (Figure 3). The separation of the two Eurasian regions may reflect poor collecting effort. In Europe it is rare at coastal dunes along the North Sea and Baltic Sea coasts, and is even more sparsely distributed in the interior (Tschorsnig and Herting 1994; Belshaw 1993). In the United Kingdom, it has been collected only once in the past 70 years (Raper 2007). Joachim Ziegler (in litt.) has assembled data for all known Eurasian collection records: 33 coastal European sites (United Kingdom, Belgium, Netherlands, Germany, Denmark, Sweden, Poland, Lithuania, and Finland); 7 interior sites (Germany, Slovakia, Hungary, Ukraine, and Russia); and 17 central Asian sites (Mongolia, China, and Russia). Although there are published reports for sites in Transcaucasia and the Czech Republic, these are in error (J. Ziegler, pers. comm.).

In North America, it is known only from dunes in the southwestern Yukon (Wood 1994; Polak 1989; Canadian Wildlife Service fieldwork 2008-2009).

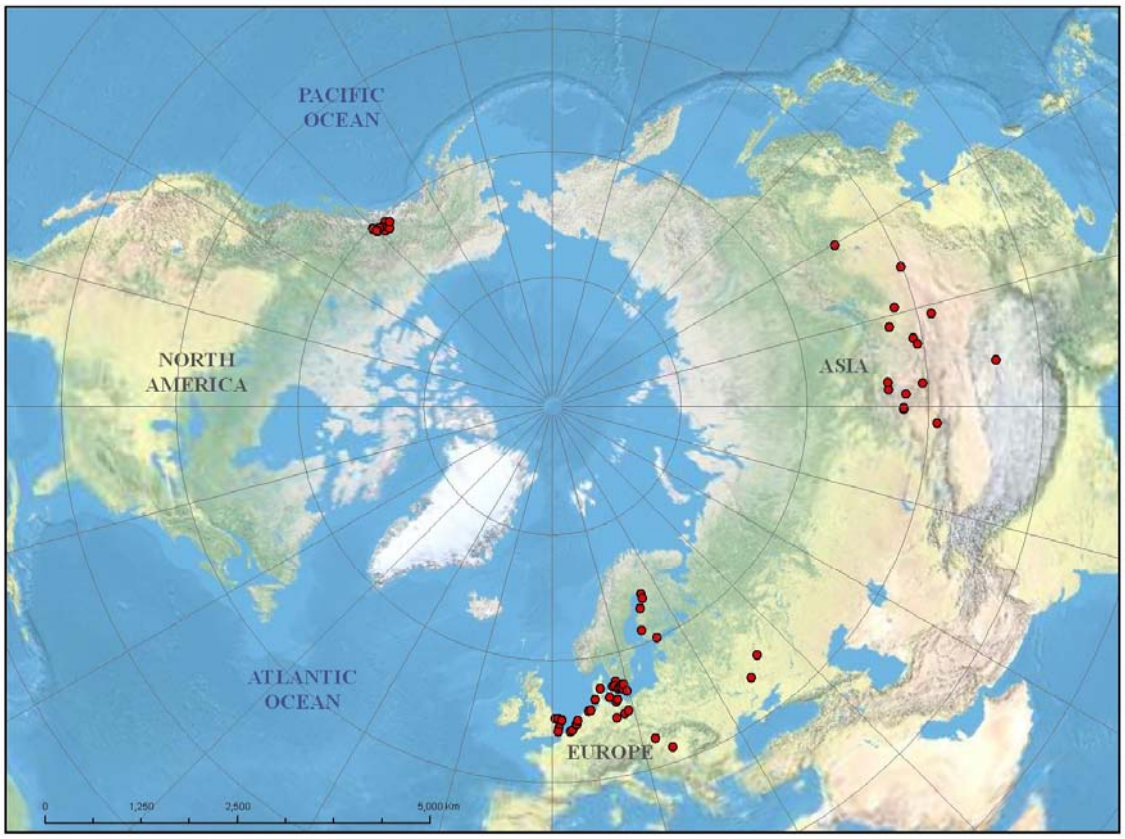

Figure 3. Global distribution of *Germaria angustata*. Some locations in Mongolia and China are approximate.

Canadian range

The species is known from 14 individual sites that make up eleven 'locations' as defined by COSEWIC (Table 1) in eight dune complexes in the southwestern Yukon: Carcross/Bennett Lake; Kusawa (upper Takhini River); Alsek River in Kluane National Park and Reserve; Slims River in Kluane National Park and Reserve; Sekulmun Lake; two, small, cliff-top blowouts near Champagne; similar blowouts around Whitehorse; and one isolated ridge-top blowout southeast of the Sekulmun Lake dunes (Figures 4, 5).

Table 1. Known locations of *G. angustata* in Canada. All locations are in the Yukon. Areas are approximations of appropriate habitat. First Nations ownership; CTFN = Carcross-Tagish First Nation; CAFN = Champagne and Aishihik First Nations; KDFN = Kwanlin Dun First Nation.

Location	Latitude N	Longitude W	Elevation (m)	Ownership	Approx. area (ha)
Aishihik Lake, 12 km W	61.4053	136.3941	1450	Crown	0.1
Alsek River	60.6698	137.8001	590	Parks Canada	50
Carcross	60.1766	134.7295	665	Crown, CTFN	80
Dezadeash River	60.8037	136.5726	700	CAFN	2
Sekulmun Lake	61.5627	137.5436	1200	CAFN	15
Slims River	60.9579	138.6362	830	Parks Canada	2
Takhini River	60.6680	136.0759	680	Crown, KDFN	20
Whitehorse, 5 km N	60.7729	135.0878	650	Crown lease	0.5
Whitehorse, bluffs to W	60.7246	135.0712	690	Crown	0.5
Whitehorse, Riverdale	60.7116	135.0316	680	Crown	3.0
Whitehorse, Schwatka L.	60.6941	135.0334	680	Crown	0.5

In calculating the number of locations, the three sites along the west bluffs of Whitehorse were considered one location. These sites, although separated by unsuitable habitat of up to 1 km, are part of the same bluff/sand complex. The next site north is 5 km away, so was considered a separate location, as it is unlikely to share a single threat (development, disturbance by vehicles, invasive plants, etc.). At the southeast corner of Whitehorse, the Schwatka Lake site was considered separate from the location on the north side of Riverdale; these locations are about 2 km apart across a suburban landscape, and about 2.4 km apart following the forested bluff edge. The Carcross dunes were sampled as two separate sites but are really part of one contiguous dune complex, so are considered one location united by threats such as invasive plants and disturbance by all-terrain vehicles. The two sites along the Dezadeash River near Champagne are along the same side of the river and only 700 m apart, so they were also considered the same location, because any local disturbance and development threats are likely to affect both sites.

It is possible that two of the locations around Whitehorse (those north of Riverdale and along the west side of the city) are sink populations, only maintained by immigration from the slightly larger populations at Schwatka Lake or perhaps from those 5 km north of the city. These are very small sites, fragmented by unsuitable forested or silty habitat, and no more than one fly has ever been captured in a visit.

Using a convex polygon around all Canadian sites, the extent of occurrence is approximately 15,600 km^2. Using a 2x2 km grid, the species is known to occupy 12 grid squares, for an index of area of occupancy of 48 km^2. The actual area of occurrence is at most approximately 200 ha, or 2 km^2. Much of this area is unvegetated sand in the large dunes, which is unsuitable habitat for this species.

Even though the Canadian distribution of *G. angustata* is probably incompletely known (see **Search effort** below), the dunes that it requires are small and sparsely distributed, and it is most likely confined to the southwestern Yukon.

There is no Aboriginal Traditional Knowledge (ATK) concerning distribution available for this species at this time.

Search effort

Prior to 2008, active searches for this species in Canada were limited to the dunes at Carcross, Yukon; Lake Athabasca, Saskatchewan; and the Great Sand Hills, Saskatchewan (Figure 4).

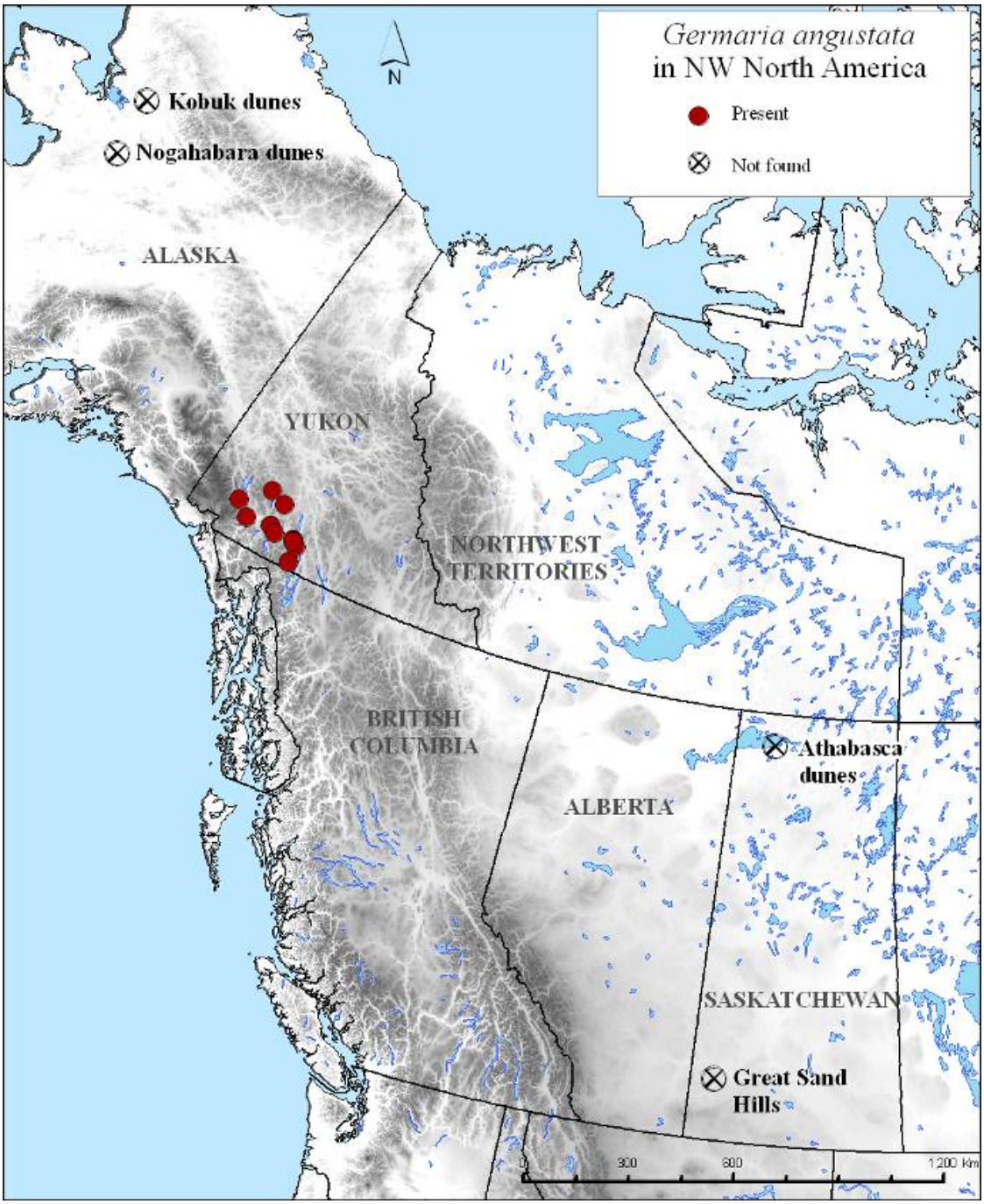

Figure 4. North American distribution of *Germaria angustata* (red dots). Other sites where specific but unsuccessful searches have been made are located by crossed dots.

The Carcross dunes were visited seven times in the 1980s by D.M. (Monty) Wood and his colleagues, although most visits were relatively brief. Nevertheless, at least 231 specimens of *G. angustata* were collected in that decade.

In 1988, Michal Polak and Monty Wood searched specifically for this species at a number of locations, but found it only at Carcross (Polak 1989). They surveyed the dunes along the south shore of Lake Athabasca, Saskatchewan, within a 2 km radius of a base camp at Yakow Lake (approximately 59^{o} 12' N, 108^{o} 02' W). Collections were made from June 23 to July 5, during warm and mostly sunny weather. They also surveyed the Great Sand Hills of Saskatchewan in mid-June that year, for several days. Finally, they searched the Kobuk and Nogahabara dune complexes in western Alaska; about a week was spent at each site in July (Figure 4; D.M. Wood, pers. comm. 2009).

In 2008, Syd Cannings and Lea Randall visited the Carcross dunes three times in late June and early July; the dunes west of the Takhini River near Kusawa Lake once in late June; and the Alsek dunes at the confluence of the Dezadeash (Alsek) and Kaskawulsh Rivers for two days in late June. Cliff-top sand sites in Whitehorse (Schwatka Lake, Riverdale, Mountain View Golf Course) were visited on one or two brief visits each (Randall and Cannings 2008).

For the 2009 inventory (led by S. Cannings, Canadian Wildlife Service), potential sites were identified first using a map of aeolian sand deposits in southern Yukon provided by Steve Wolfe of the Geological Survey of Canada (Figures 6, 7). To check for active dunes, i.e., those potentially inhabited by *Germaria*, the sites were assessed further using satellite imagery from Google™ Earth, and aerial photos from the library of the Yukon government's Energy, Mines and Resources department. Some small sites in Whitehorse were identified by sight alone. Identified sites were prioritized for visit by apparent suitability and by ease of access.

In all of Yukon it is estimated that there are approximately 30 potential sites. Of these sites, 26 were visited in 2009 at least once for a minimum of 30 minutes during good weather. Dune Tachinid Flies were absent from half of these sites. Site visits are detailed in Table 3 and sites are mapped in Figure 5. Search effort in 2008 and 2009 totaled approximately 64 person-hours.

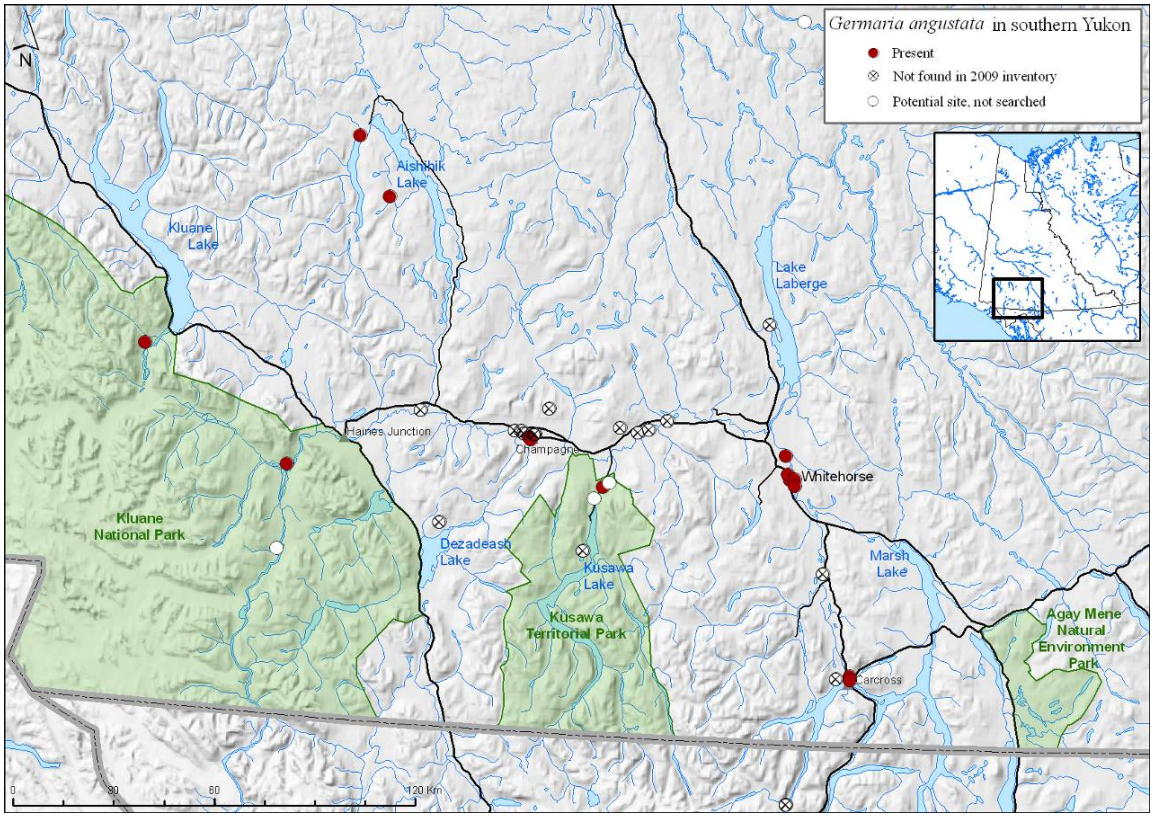

Figure 5. Known distribution of *G. angustata* in Canada.

Four Yukon sites that hold potential for *Germaria* were not visited, primarily because of difficulty of access. These are mapped in Figure 5 as open circles. Two dunes are in the immediate vicinity of the Takhini River dune (Kusawa Territorial Park) but, because they lie on the east shore of the river, are only accessible by canoe or helicopter. These may be considered part of the same location,as defined by COSEWIC. Similarly the dunes along the Alsek River, 25 km south of those at the junction of the Kaskawulsh and Dezadeash Rivers, were inaccessible without the use of a helicopter or raft. Finally, small cliff-top dunes along the Yukon River, 10 km N of Big Salmon Village, appear similar in photographs to those at Whitehorse.

Although there are many aeolian sand deposits west of Pelly Crossing (Figure 6), no open, active dunes could be seen in aerial photographs, and no sites were ground-checked during *Germaria* flight season. One large dune complex immediately south of the confluence of the Pelly and Yukon Rivers (at directional arrow east of Pelly Crossing in Figure 6) was visited in early October, 2009, but no active sand areas were found.

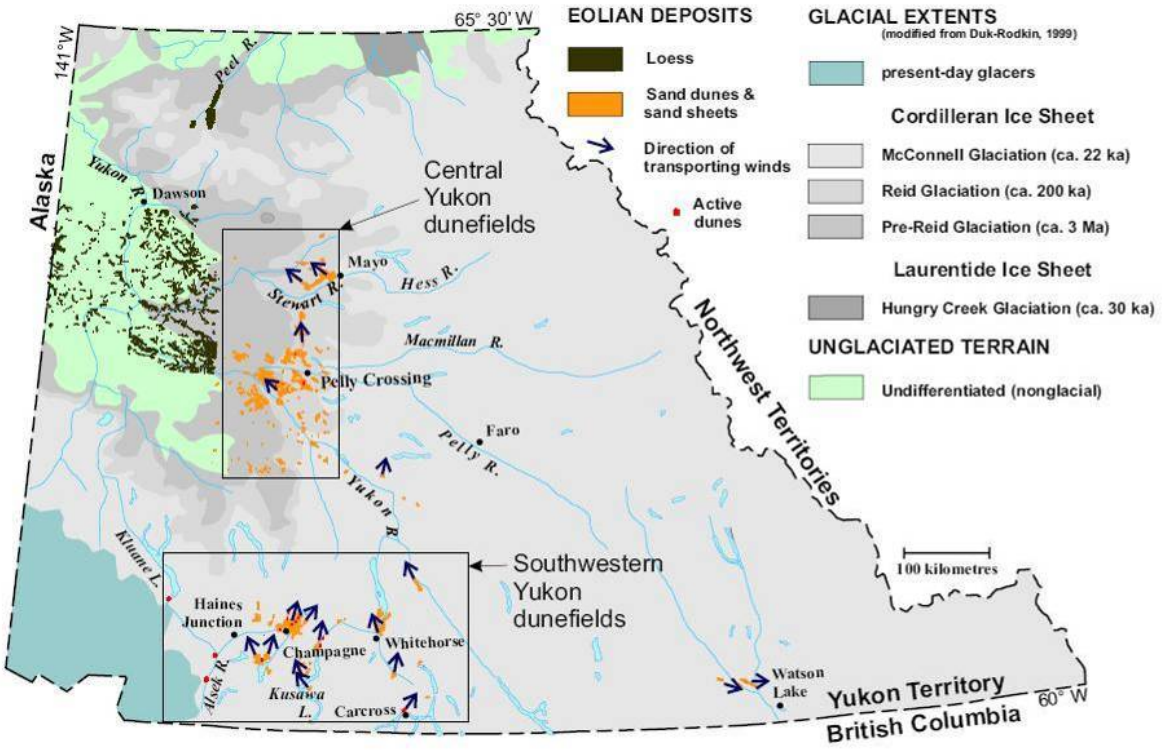

Figure 6. Aeolian deposits of the southern Yukon. Map courtesy of Stephen Wolfe, Geological Survey of Canada, Ottawa.

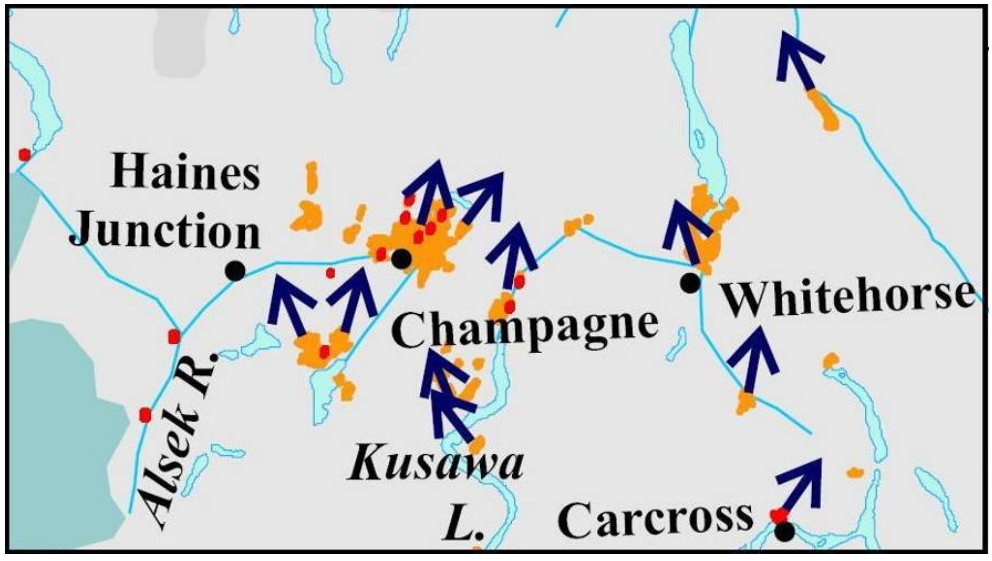

Figure 7. Aeolian deposits of the southwestern Yukon (enlarged from lower inset in Figure 6). Vegetated, stabilized dunes in orange; active dunes in red; direction of transporting winds marked by arrows. Map courtesy of Stephen Wolfe, Geological Survey of Canada, Ottawa.

There are a few active dunes in the NWT (S. Wolfe, pers. comm.), but these are outside Beringia and similar sites in Saskatchewan have been surveyed without success (Polak 1989). A brief focused survey (Greg Pohl, Colin Jones, Syd Cannings for 3 hours in 2010) and numerous general insect surveys in the region of Fort Smith (which has a number of sandy sites in and around the settlement) have recorded probable host moths, but no *Germaria* specimens. There have been general insect surveys, but no focused surveys for *Germaria* in the dunes in the Jasper, Alberta area, where probable host moths have been found. Finally, there have been a number of general insect surveys of the coastal dunes of British Columbia (e.g., at Naikoon Provincial Park on Graham Island, and Pacific Rim National Park on Vancouver Island), but there may have been no specific searches for tachinid flies there.

In summary, it is possible that *G. angustata* occurs at a few more sites in the Yukon, but these would probably result in a total of fewer than 20 locations. There are also other possible sites in northwestern Canada outside the Yukon, but these are considered unlikely to have *G. angustata* populations. Similarly, dunes elsewhere in Canada including the prairie region and Great Lakes have been subjected to extensive study by entomologists without any indication of *G. angustata* occurring there (D.M. Wood, pers. comm.). Finally the surveys noted above that contribute to these conclusions were completed in appropriate mild, sunny weather as indicated or involved relatively long periods when such weather likely occurred, so that weather is not considered a constraint of the analysis.

HABITAT

Habitat requirements

Germaria angustata is restricted to sites where its (as yet unknown) host moth lives, and to habitats that meet the requirements of the larva of this moth. Throughout its range, it is restricted to active dunes, although the dunes can be found anywhere from coastal Europe to the subalpine zone in the Yukon.

In the southwestern Yukon, *G. angustata* is found in active dunes and blowouts with sparse vegetation, where sand is being deposited but the dune is somewhat stabilized. All sites where it was found in 2009 are >60% open sand. However, much of the area of large dunes such as those along the highway north of Carcross, or those along the Takhini River, are essentially 100% open sand, and these areas support few if any *G. angustata*. Photographs of most of the sites are presented in Figures 8-22; these photographs were all taken in 2008 and 2009.

Figure 8. Dunes at Bennett Lake beach, Carcross. SW from 60.1776˚N 134.7295˚W, 1 June 2009. Photo: S. Cannings

Figure 9. Typical *G. angustata* habitat at the Bennett Lake beach dunes. Common plants include: *Calamagrostis purpurascens*, *Elymus calderi*, *Bromus pumpellianus*, *Carex sabulosa*, *Polemonium pulcherrimum*, *Artemisia frigida*, and *Aster sibiricus*. N from approx. 60.1776˚N 134.7295˚W, 22 July 2009. Photo: L. Schroeder; used with permission.

Figure 10. Dunes 2 km N of Carcross, along Klondike Highway. Sparse cover in foreground is *Carex sabulosa; Germaria angustata* is not present in this grassless habitat. Note off-road vehicle disturbance. S from 60.1864˚N 134.6936˚W, 20 June 2008. Photo: S. Cannings

Figure 11. *G. angustata* habitat at the Carcross dunes: Baikal Sedge (*Carex sabulosa*), grasses (*Bromus pumpellianus*, etc.) and wildflowers (*Lupinus kuschei, Aster sibiricus, Polemonium pulcherrimum*). Note off-road vehicle disturbance. N from 60.1881˚N 134.6934˚W, 1 June 2010. Photo: S. Cannings.

Figure 12. Alsek dunes at confluence of Kaskawulsh and Dezadeash (Alsek) Rivers, Kluane National Park and Reserve. Vegetation includes *Carex sabulosa, Equisetum arvense, Lupinus kuschei,* and *Artemisia tilesii,* with occasional clumps of *Juniperus communis.* W from 60.6680˚N 137.8003˚W, 2008. 26 June 2008. Photo: S. Cannings.

Figure 13. Mixed *Carex sabulosa*-grass-*Lupinus kuschei-Penstemon gormani-Artemisia tilesii* community, Alsek dunes. NE from 60.6698˚N 137.8000˚W, 26 June 2008. Photo: S. Cannings.

Figure 14. Aerial view of the dune on the west side of the Takhini River, 6.8 km NNE of Kusawa Lake. Large dune is approximately 900 m long, but most of this dune is not appropriate habitat for *G. angustata*. NW from approximately 60.660˚N 136.064˚W, 13 October 2009. Photo: J. Meikle, Kwanlin Dun, First Nation; used with permission.

Figure 15. Vegetated dune swale on the west side of the Takhini River, 6.8 km NNE of the outlet of Kusawa Lake. Appears as greyish streak on near side of dune in centre of Figure 14. Common plants include *Carex sabulosa, Elymus calderi,* and *Lupinus kuschei*. NNE from 60.6679˚N 136.0763˚W, 19 June 2009. Photo: S. Cannings.

Figure 16. Aeolian sand and active dunes on top of lacustrine silt cliffs eroded by Yukon River, 5 km N of Whitehorse. SW from 60.7748˚N 135.0826˚W, 17 July 2008. Photo: S. Cannings.

Figure 17. Blowout on top of bluffs above Yukon River, 5 km N of Whitehorse (in middle distance of Figure 15): common plants include *Penstemon gormanii, Oxytropis campestris,* and *Elymus calderi*. N from 60.7736˚N 135.0863˚W, 7 June 2009. Photo: S. Cannings.

Figure 18. Aeolian sand and dunes on top of coarser sediments on Lookout Hill, at north end of Schwatka Lake reservoir, Whitehorse. Dominant grasses are *Oryzopsis hymenoides, Elymus calderi,* and *Calamagrostis purpurascens.* W from 60.6940˚N 135.0322˚W, 12 July 2008. Photo: S. Cannings.

Figure 19. Stabilized dunes and small blowouts; aeolian sand on top of silt bluffs, west of downtown Whitehorse. *Calamagrostis purpurascens* in foreground; other vegetation dominated by *Artemisia frigida, Carex supina, and Elymus trachycaulus*. NNW from 60.7249˚N 135.0712˚W, 2 July 2009. Photo: S. Cannings.

Figure 20. Dunes at confluence of Bullion Creek and Slims River, Kluane National Park and Reserve. Dominant plants are *Elymus calderi* and *Artemisia frigida*. SSW from 60.9608˚N 135.6348˚W, 3 July 2009. Photo: S. Cannings.

Figure 21. Beach dunes at north end of Sekulmun Lake. Foreground vegetation includes *Bromus pumpellianus*, *Hierochloe hirta* ssp. *arctica*, *Artemisia alaskana, Lupinus kuschei, Phlox hoodii,* and *A. uva-ursi*. This was the site with the densest populations of *G. angustata*.WNW from 61.5619˚N 137.5418˚W, 13 July 2009. Photo: S. Cannings.

Figure 22. Ridge-top aeolian sand and small blowouts in subalpine zone (1200 m el.) between Aishihik and Sekulmun Lakes. E from 61.4049˚N 137.3540˚W (on helicopter approach), 13 July 2009. Photo: S. Cannings.

Figure 23. Increased ATV use at Carcross over the past 30 years may have caused a decline in the area of appropriate habitat for *G. angustata*. W from approximately 60.1852˚N 134.6929˚W, 20 June 2008. Photo: S. Cannings.

Although the sites vary in size and in plant community composition, a consistent feature is the presence of scattered grasses. Polak (1989) noted that *G. angustata* has been observed to lay eggs on the grass *Bromus pumpellianus,* and inferred that the larva of its host moth probably eats grasses. No single grass species occurs at all sites, but *Festuca saximontana, Bromus pumpellianus, Calamagrostis purpurascens* var. *purpurascens,* and *Elymus calderi* are frequent, and *E. trachycaulus* is sometimes present (Table 3). Baikal Sedge, *Carex sabulosa* (listed as Threatened under the *Species at Risk Act*) is a dominant feature of many of the sites, but *Germaria* is found at a number of sites where *C. sabulosa* is absent, and is absent at a number of sites where *C. sabulosa* is present. In fact, *G. angustata* was never found where *C. sabulosa* was the only plant species present. Other frequent plant species include *Artemisia campestris, A. frigida, Aster sibiricus, Equisetum arvense, Lupinus kuschei, Oxytropis campestris, Penstemon gormanii, Pinus contorta, Populus balsamifera, P. tremuloides, Polemonium pulcherrimum, Solidago simplex,* and *Stellaria longipes* (COSEWIC 2005; inventory associated with present report, Table 2).

Table 2. Canadian specimens of *G. angustata* held in the Canadian National Collection, Agriculture and Agri-Food Canada, Ottawa.

Location	Date	Collector(s)	Number of specimens
Yukon, Carcross dunes	17.vii.1980	M. Wood, D. Lafontaine	67
Yukon, Carcross dunes	22-23.vii.1981	D. Lafontaine, G. & M. Wood	45
Yukon, Carcross dunes	31.vii.1982	M. Wood	4
Yukon, Carcross dunes	15.vi.1984	G. & M. Wood	13
Yukon, Carcross dunes	19-20.vii.1987	M. Polak, M. Wood	67
Yukon, Carcross dunes	25.vii.1988	M. Polak, M. Wood	33
Yukon, Carcross dunes	22.vii.1989	M. Polak, M. Wood	7

Table 3. Details on site inventories in 2008 and 2009 by Canadian Wildlife Service and Environment Yukon. Records highlighted in yellow indicate surveys that resulted in the capture of at least one *G. angustata* specimen. 'Total' indicates the number of *G. angustata* specimens taken. Specimens will be deposited at Canadian National Collection, Agriculture and Agri-Food Canada, Ottawa; Canadian Wildlife Service, Whitehorse; Royal British Columbia Museum, Victoria; and Museum für Naturkunde, Berlin.

Location	Habitat	Elev. (m)	Latitude N	Longitude W	Date	Total	Collector(s)
Aishihik L., 12 km W	Ridge top aeolian sand; scattered grass, *Artemisia frigida*	1450	61.40527	136.39412	13-Jul-09	2	S. Cannings
Alsek River dunes	dunes with scattered grasses and forbs	590	60.67177	137.79463	26-Jun-08	0	L. Randall
Alsek River dunes	dunes with scattered grasses and forbs	590	60.66975	137.80010	26-Jun-08	12	L. Randall
Alsek River dunes	dunes with scattered grasses and forbs	590	60.66817	137.80010	26-Jun-08	3	L. Randall
Alsek River dunes	dunes with scattered grasses and forbs	590	60.67177	137.79463	27-Jun-08	3	S. Cannings
Alsek River dunes	dunes with scattered grasses and forbs	590	60.66975	137.80010	27-Jun-08	12	S. Cannings
Alsek River dunes	dunes with scattered grasses and forbs	590	60.66817	137.80010	27-Jun-08	10	S. Cannings
Bennett L., W of Watson R.	Open dune patches, mostly stabilized and surrounded with *Arctostaphylos uva-ursi*, little grass present	670	60.18013	134.76746	27-Jul-09	0	L. Mennell
Bennett, BC, 0.45 km SW	Bare, bald gravel/sand hill	690	59.84258	135.00198	22-Jun-09	0	L. Mennell
Bennett, BC, 0.5 km SW	Sparse pine, and sand dunes, *A. uva-ursi,* lichen and moss crusts, no grass	690	59.84244	135.00356	21-Jun-09	0	L. Mennell
Bennett, BC, 0.5 km SW	Sparse pine, and sand dunes, *A. uva-ursi,* lichen and moss crusts, no grass	690	59.84244	135.00356	22-Jun-09	0	L. Mennell
Bennett, BC, 1.0 km SW	Sparse pine, and sand dunes, *A. uva-ursi,* lichen and moss crusts, no grass	715	59.83903	135.01004	21-Jun-09	0	L. Mennell
Bennett, BC, 1.0 km SW	Sparse pine, and sand dunes, *A. uva-ursi,* lichen and moss crusts, no grass	715	59.83903	135.01004	22-Jun-09	0	L. Mennell
Canyon, 3 km SW	Aeolian sand atop silt bluffs; large blowout dune; diverse vegetation with grasses	670	60.84129	137.09482	13-Jul-09	0	S. Cannings, L. Mennell
Carcross, Bennett L.	Dunes behind beach; scattered grasses and forbs	660	60.17361	134.72300	20-Jun-08	1	S. Cannings, L. Randall

Location	Habitat	Elev. (m)	Latitude N	Longitude W	Date	Total	Collector(s)
Carcross, Bennett L.	Dunes behind beach; scattered grasses and forbs	660	60.17020	134.71733	25-Jun-08	4	J. Spence
Carcross, Bennett L.	Dunes behind beach; scattered grasses and forbs	660	60.17168	134.71990	25-Jun-08	1	L. Randall
Carcross, Bennett L.	Dunes behind beach; scattered grasses and forbs	670	60.178313	134.69537	21-May-09	0	S. Cannings
Carcross, Bennett L.	Dunes behind beach; scattered grasses and forbs	670	60.178313	134.69537	1-Jun-09	0	S. Cannings
Carcross, Bennett L.	Dunes behind beach; scattered grasses and forbs	670	60.178313	134.69537	10-Jun-09	0	S. Cannings, L. Mennell
Carcross, Bennett L.	Dunes behind beach; scattered grasses and forbs	670	60.178313	134.69537	12-Jun-09	0	S. Cannings
Carcross, Bennett L.	Dune blowout stabilized by *Carex sabulosa, Elymus calderi, Bromus pumpellianus, Aster sibiricus, Lupinus kuschei;* active blowing sand along shoreline.	665	60.17042	134.71765	25-Jun-09	0	L. Mennell
Carcross, Bennett L.	Ridge top of dune, stabilized; *Lupinus kuschei, C. sabulosa, Populus balsamifera,* grasses	665	60.17066	134.71809	25-Jun-09	0	L. Mennell
Carcross, Bennett L.	Bluff top; short *P. balsamifera* with open sand areas, *Oxytropis campestris, Polemonium pulcherrimum, Equisetum arvense*	665	60.17125	134.71872	25-Jun-09	0	L. Mennell
Carcross, Bennett L.	*P. balsamifera* thickets behind active sand dune area	660	60.17662	134.72949	25-Jun-09	0	L. Mennell
Carcross, Bennett L.	Dune blowout stabilized by *C. sabulosa, Elymus calderi, B. pumpellianus, Aster sibiricus, L. kuschei;* active blowing sand along shoreline.	665	60.17042	134.71765	15-Jul-09	5	L. Mennell
Carcross, Bennett L.	Dune blowout stabilized by *Carex sabulosa, E. calderi, B. pumpellianus, Aster sibiricus, L. kuschei;* active blowing sand along shoreline.	665	60.17042	134.71765	15-Jul-09	1	L. Mennell

Location	Habitat	Elev. (m)	Latitude N	Longitude W	Date	Total	Collector(s)
Carcross, Bennett L.	Small dune hill top, clumps of short *P. balsamifera* amongst open sand	665	60.17042	134.71802	15-Jul-09	6	L. Mennell
Carcross, Bennett L.	Stabilized blowout behind active foreshore dunes	665	60.17741	134.73042	15-Jul-09	0	L. Mennell
Carcross, Bennett L.	Immediate foreshore dunes, active sand, *P. balsamifera, C. sabulosa, L. kuschei*	660	60.17662	134.72949	22-Jul-09	1	L. Mennell
Carcross, Bennett L.	Top and lee side of large sand hill, some active sand; *C. sabulosa, L. kuschei, A. campestris*	674	60.17793	134.7309	22-Jul-09	0	L. Mennell
Carcross, Bennett L.	Small dune hill top, clumps of short *P. balsamifera* amongst open sand	670	60.17042	134.71802	22-Jul-09	2	L. Mennell
Carcross, Bennett L.	open sand	660	60.17042	134.71802	22-Jul-09	0	L. Mennell
Carcross, Bennett L.	stabilized dunes with open sandy patches; *O. campestris, Stellaria longipes*, grasses	665	60.17735	134.72881	24-Jun-09	0	L. Mennell
Carcross, Bennett L.	Immediate foreshore dunes, active sand, *P. balsamifera, Bromus pumpellianus, Artemisia campestris, C. sabulosa, L. kuschei*	660	60.17662	134.72949	24-Jun-09	3	L. Mennell
Carcross, Bennett L.	Old dune ridge top, stabilized but open; grass sp., *C. sabulosa, L. kuschei, A. campestris*	665	60.17791	134.72995	24-Jun-09	0	L. Mennell
Carcross, Bennett L.	Foreshore active dunes, behind clumps of *P. balsamifera*, with *C. sabulosa, L. kuschei, Calamagrostis purpurascens*	665	60.17741	134.73042	24-Jun-09	5	L. Mennell
Carcross, Bennett L.	Top and lee side of large sand hill, some active sand; *C. sabulosa, L. kuschei, A. campestris*	675	60.17793	134.7309	24-Jun-09	6	L. Mennell
Carcross, Bennett L.	Large level blowout; grasses, *O. campestris, C. sabulosa, L. kuschei*	660	60.17817	134.73096	24-Jun-09	2	L. Mennell
Carcross, Bennett L.	Westernmost blowout, active shore dune, sparse vegetation; *O. campestris, A. campestris, C. purpurascens*	665	60.179	134.73303	24-Jun-09	2	L. Mennell

Location	Habitat	Elev. (m)	Latitude N	Longitude W	Date	Total	Collector(s)
Carcross, Bennett L.	wide shallow stabilized blowout, adjacent to active sand along shoreline; *C. sabulosa, E. calderi, B. pumpellianus, A. sibiricus, L. kuschei*	665	60.17042	134.71765	25-Jun-09	4	L. Mennell
Carcross, dunes 2 km N	dunes / open slightly vegetated	695	60.18527	134.69190	20-Jun-08	1	S. Cannings, L. Randall, K. Kuba
Carcross, dunes 2 km N	*C. sabulosa* 'lawn,' halfway up highest blowout; *B. pumpellianus, A. sibiricus, P. pulcherrimum*	695	60.188106	134.692920	13-Jul-08	7	S. Cannings
Carcross, dunes 2 km N		695	60.188106	134.692920	21-May-09	0	S. Cannings
Carcross, dunes 2 km N	*Carex sabulosa* 'lawn,' ; *B. pumpellianus, A. sibiricus, P. pulcherrimum*	695	60.188106	134.692920	7-Jul-09	7	L. Mennell
Champagne, 1.4 km NE	S-facing, active blowout; *C. sabulosa* present; dunes encroached by *A. uva-ursi*	730	60.79627	136.4655	23-Jul-09	0	L. Mennell, L. Schroeder
Champagne, 1.6 km NE	stabilized dune blowouts encroached by *A. uva-ursi*	730	60.7984	136.46426	23-Jul-09	0	L. Mennell, L. Schroeder
Champagne, Dezadeash R.	Sand blowouts along river	700	60.78236	136.48228	20-Jul-09	2	L. Mennell
Chilkoot Trail, Two Pond boardwalk	Dry gravelly hill, lichens, pine, *A. uva-ursi*	715	59.82383	135.01492	21-Jun-09	0	L. Mennell
Dezadeash Lake, 2 km N	Sand blowouts, sparsely vegetated; some *C. sabulosa*	880	60.54589	136.9501	13-Jul-09	0	S. Cannings
Dezadeash R., 0.7 km NW of Champagne	Active riverside dunes; grasses and forbs, *Rosa acicularis*	700	60.78959	136.4954	8-Jul-09	5	S. Cannings
Dezadeash R., 0.7 km NW of Champagne	Active riverside blowout/dunes; *E. arvense, B. pumpellianus, Alnus* sp.	700	60.78959	136.4954	8-Jul-09	1	S. Cannings
Dezadeash R., 0.7 km NW of Champagne	Active riverside blowout/dunes; *E. arvense, B. pumpellianus*.	700	60.78959	136.4954	8-Jul-09	0	L. Mennell
Dezadeash R., 0.7 km NW of Champagne	Active riverside blowout/dunes; *E. arvense, B. pumpellianus;* flower meadow behind blowout ridge	700	60.78959	136.4954	8-Jul-09	0	L. Mennell

Location	Habitat	Elev. (m)	Latitude N	Longitude W	Date	Total	Collector(s)
Dezadeash R., 2.6 km NW of Champagne	Riverside blowout dunes, silty sand, some active, moving into open aspen forest /grassland, *C. sabulosa* present	700	60.7984	136.52347	9-Jul-09	0	L. Mennell
Dezadeash R., 2.6 km NW of Champagne	East lobe of river bend; similar to site to W, but more stabilized	700	60.7984	136.52347	9-Jul-09	0	L. Mennell
Dezadeash R., 3.7 km NW of Champagne	Hillside blowouts above old river channel, mostly stable; *C. sabulosa* present, but few grasses	700	60.80452	136.53953	9-Jul-09	0	L. Mennell
Dezadeash R., 5.3 km NW of Champagne	Sand riverbank, small blowouts on top; *C. sabulosa*, small *P. balsamifera,* grasses	700	60.80365	136.57261	8-Jul-09	0	S. Cannings, L. Mennell
Fox Creek, Lake Laberge	Old beach ridges, stabilized and forested	635	61.12233	135.20351	3-Jun-09	0	S. Cannings
Kusawa Territorial Park, “Ten-Mile” Lake	sand/gravel beach; old beach ridges with no open sand, moss/lichen crust, *A. uva-ursi,* some pine and spruce	810	60.49353	136.16231	6-Jul-09	0	L. Mennell
Lindeman L., N end, BC	Sparse pine, stabilized dunes; *A. uva-ursi*, lichen and moss crusts, no grasses	680	59.83437	135.01241	21-Jun-09	0	L. Mennell
Lindeman L., N end, BC	Sparse pine, stabilized dunes; *A. uva-ursi*, lichen and moss crusts, no grasses	680	59.83437	135.01241	21-Jun-09	0	L. Mennell
Robinson		750	60.46057	134.86176	13-Jul-08	0	S. Cannings
Robinson	Sandy blowouts among stabilized dunes; pine-lichen woodland	750	60.46057	134.86176	21-May-09	0	S. Cannings
Robinson	Sandy blowouts among stabilized dunes; pine-lichen woodland; *C. sabulosa* present	750	60.46057	134.86176	10-Jun-09	0	S. Cannings
Sekulmun L., N end	Open aeolian sand, stabilized dunes and blowouts; *B. pumpellianus, Hierochloe hirta, Calamagrostis purpurascens, Festuca saximontana, Carex supine, Phlox hoodii, L. kuschei, Bupleurum americanum, Artemisia alaskana*	900	61.56272	137.54361	13-Jul-09	13	S. Cannings

Location	Habitat	Elev. (m)	Latitude N	Longitude W	Date	Total	Collector(s)
Slims R., S of Bullion Cr.	Large dunes, *E. calderi, B.pumpellianus, Artemisia frigida, Lesquerella arctica, R. acicularis, Erigeron caespitosus, Comandra umbellata*	840	60.96082	138.63483	3-Jul-09	10	S. Cannings, L. Mennell
Slims R., S of Bullion Cr.	Base of dunes, wind-scoured, fine sand and patches of alkaline soil; grasses, *Carex maritima, Salix* spp., and dead trees	830	60.9579	138.63622	3-Jul-09	4	S. Cannings, L. Mennell
Stony Creek	Aeolian sand deposits and small blowouts on top of silt/gravel stream canyon cliff	860	60.82779	136.00017	28-Jul-09	0	S. Cannings
Takhini R., 6.8 km NNE of Kusawa L.	End of dune swale	680	60.66855	136.07340	24-Jun-08	2	S. Cannings, L. Randall
Takhini R., 6.8 km NNE of Kusawa L.	Small, active blowout and dune along river; *C. sabulosa* dominant	665	60.67018	136.06421	24-Jun-08	0	S. Cannings, L. Randall
Takhini R. bridge, Alaska Hwy.	Sand blowouts along top of riverbank	660	60.8522	135.74068	19-Jun-09	0	S. Cannings
Takhini R., 10 km ENE of Mendenhall Landing	Silt bluff tops	660	60.81694	135.90222	30-Jul-09	0	S. Cannings
Takhini R., 10.6 km. NE Mendenhall landing		660	60.80894	135.88124	13-Jun-09	0	K. Halliday
Takhini R., 13.3 km ENE of Mendenhall Landing	Steep sand bank and small ridge-top dunes; some grasses	660	60.8264	135.84251	30-Jul-09	0	S. Cannings
Takhini R., 6.8 km NNE of Kusawa L.	Large dunes; *C. sabulosa, L. kuschei* on slope	680	60.66796	136.07826	19-Jun-09	0	S. Cannings
Takhini R., 6.8 km NNE of Kusawa L.	Large dunes; *C. sabulosa* on W-facing slope	680	60.66824	136.07664	19-Jun-09	0	S. Cannings
Takhini R., 6.8 km NNE of Kusawa L.	*Carex sabulosa*, sparse grasses and forbs in stabilized dune swale	680	60.66798	136.07587	19-Jun-09	0	S. Cannings
Takhini R., 6.8 km NNE of Kusawa L.	Large dunes, willow knoll with *C. sabulosa, L. kuschei*	680	60.66786	136.07817	21-Jul-09	3	L. Mennell, L. Schroeder
Takhini R., 6.8 km NNE of Kusawa L.	Large dunes, stabilized swale with scattered *C. sabulosa, L. kuschei, E. calderi*	680	60.66788	136.07625	21-Jul-09	5	L. Mennell, L. Schroeder

Location	Habitat	Elev. (m)	Latitude N	Longitude W	Date	Total	Collector(s)
Takhini R., 6.8 km NNE of Kusawa L.	Large dunes, more protected lobe of dune, less active sand	680	60.66938	136.07251	21-Jul-09	0	L. Mennell, L. Schroeder
Takhini R., 6.8 km NNE of Kusawa L.	S-facing slope at N end of largest blowout, and trail out of this peak	680	60.67007	136.07364	21-Jul-09	3	L. Mennell, L. Schroeder
Takhini R., 6.8 km NNE of Kusawa L.	Small, active blowout and dune along river; *C. sabulosa* dominant	665	60.67074	136.06471	31-Jul-09	0	L. Mennell
Taye L., 6 km W	Subalpine dune blowouts, sparse *C. sabulosa* lawns	1200	60.86753	136.39412	13-Jul-09	0	S. Cannings
Whitehorse, bluffs N of airport	Stabilized dunes, blowouts, and steep sand bank on top of silt bluffs; grasses dominated by *C. purpurascens* and *E. trachycaulus; A. frigida, Penstemon procerus,* and *Carex supina*. *Poa glauca, Bromus inermis* and *B. pumpellianus* behind ridge.	695	60.72455	135.07115	2-Jul-09	2	S. Cannings, L. Mennell
Whitehorse, 5 km N	Cliff-top dunes	650	60.772948	135.08775	11-Jul-08	5	S. Cannings
Whitehorse, 5 km N	Cliff-top dunes	650	60.772948	135.08775	21-May-09	0	S. Cannings
Whitehorse, 5 km N	Cliff-top dunes	650	60.772948	135.08775	24-May-09	0	S. Cannings
Whitehorse, 5 km N	Cliff-top dunes	650	60.772948	135.08775	7-Jun-09	0	S. Cannings
Whitehorse, 5 km N	Cliff-top dunes	650	60.772948	135.08775	17-Jul-09	2	S. Cannings, L. Mennell
Whitehorse, S end of airport	Bluff top sand areas	690	60.7107	135.05763	30-Jun-09	3	S. Cannings, L. Mennell
Whitehorse, N end of airport	Sand deposits and small active aeolian deposits on top of silt cliffs; scattered grasses	690	60.71628	135.06357	2-Jul-09	4	S. Cannings, L. Mennell
Whitehorse, Riverdale, “Vee”	Disturbed blowout, scattered *C. sabulosa*, grasses	680	60.7116	135.0316	15-Jun-09	0	S. Cannings, L. Mennell
Whitehorse, Riverdale, “Vee”	Disturbed blowout, scattered *C. sabulosa*, grasses	680	60.7116	135.0316	30-Jun-09	0	S. Cannings, L. Mennell
Whitehorse, Riverdale, “Vee”	Sandy blowout, scattered *C. sabulosa*, grasses	680	60.7116	135.0316	6-Jul-09	1	S. Cannings
Whitehorse, Riverdale, E of “Vee”	small sand blowouts on S-facing slope	675	60.71193	135.02734	14-Jul-08	1	L. Randall, S. Cannings

Location	Habitat	Elev. (m)	Latitude N	Longitude W	Date	Total	Collector(s)
Whitehorse, Riverdale, Grey Mtn. Rd.	large sand blowout, little vegetation	690	60.71019	135.01607	14-Jul-08	1	L. Randall, S. Cannings
Whitehorse, Schwatka L., N end	steep sand bank and small ridgetop dunes; scattered grass clumps	680	60.694137	135.03339	12-Jul-08	5	S. Cannings
Whitehorse, Schwatka L., N end	steep sand bank and small ridgetop dunes; scattered grass clumps	680	60.694137	135.03339	23-May-09	0	S. Cannings
Whitehorse, Schwatka L., N end	steep sand bank and small ridgetop dunes; scattered grass clumps	680	60.694137	135.03339	6-Jun-09	0	S. Cannings
Whitehorse, Schwatka L., N end	steep sand bank and small ridgetop dunes; scattered grass clumps	680	60.694137	135.03339	9-Jun-09	1	S. Cannings, L. Mennell
Whitehorse, Schwatka L., N end	steep sand bank and small ridgetop dunes; scattered grass clumps	680	60.694137	135.03339	26-Jun-09	2	L. Mennell

Dunes are maintained by a constant source of open sand and consistent winds. At Carcross and Sekulmun Lakes the source is abundant beach sand, and the lakes are oriented so that the prevailing southerly winds hit the beach with force (Figures 8 and 19). At the various river sites, the river runs through deposits that are either wholly sand or are capped by thick sand deposits. These deposits are kept open through constant erosion from below, and are blown into dunes where the river runs at right angles to the prevailing wind (e.g., Figure 15).

The elevation of these sites ranges from 660 m at Bennett Lake to 1450 m on the ridge between Sekulmun and Aishihik Lakes.

There are several aeolian sand sites with active blowouts in southwestern Yukon that are not now directly associated with a lake or a river (e.g., Robinson, Taye Lake, and Dezadeash Lake areas), but *G. angustata* has not been found in these blowouts which are among those mapped in Figure 5 as “searched but without finding *G. angustata*”.

Habitat trends

In the long term, the dune habitat of *Germaria angustata* in Canada has been substantially reduced since glaciation through natural succession (Figures 5, 6). The few, small active dunes that remain are those that can be maintained by a consistent source of materials and consistent winds (see **Habitat** section above).

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

The Alsek dunes located at the junction of the Kaskawulsh and Dezadeash Rivers in Kluane National Park are younger than most of the other dunes in the region, because they are located on the site of Recent Lake Alsek. This proglacial lake, formed by the damming of the Alsek River by the Lowell Glacier, existed as late as 1852, and would have been about 10 to 50 m deep at the present dune site (Kindle 1952; Johnson and Raup 1964). Portions of these young dunes now appear to be undergoing stabilization as vegetation invades (although there is no time sequence data), and it seems likely that the active dunes will be smaller in the future.

G.W. Douglas (in COSEWIC 2005) made the observation that, between 1974 and 2003, the large central area of the dunes along the Klondike Highway near Carcross has “remained mostly unvegetated.” In other words, he saw no noticeable decrease in vegetation at that site in recent decades. He reasoned that vegetation was not able to establish there because of the exceptionally strong winds that come off Bennett Lake and directly hit the southwest-facing slope below Caribou Mountain. This may be true for the primary, steeper slope, but local residents recall that, in general, the dunes next to the highway were more vegetated with grass and flowers in the 1970s than they are now (R.L. Mennell, pers. comm. 2009). Figure 24 and 25 compare the Carcross dunes as they were 26 years ago in 1984 with a 2010 view. Today, there are only small patches of sparse grass and forbs in this part of the complex; even areas that are relatively flat are mostly completely devoid of vegetation (Figure 11). It is possible that up to 10 ha of formerly suitable habitat has been degraded; approximately 12% of the Carcross complex. The cause of this decline is undoubtedly the increase in recreational motorcycle and All-terrain Vehicle (ATV) traffic in that area in the past 30 years (Figures 10, 11, and 23). Motorized traffic has also destroyed vegetation in small, linear portions of the Carcross beach dunes.

Figure 24. Northern section of the Carcross dunes, east of the Klondike Highway, 2 km N of the village. NNE from about 60.1866˚N 134.6951˚W, 29 August 1984. Compare vegetation with present-day photo in Figure 25. Photo: C. Kennedy; used with permission.

Figure 25 Same view as Figure 24; 1 June 2010. Note apparently increased disturbance, smaller patches of vegetation, and virtual absence of vegetation on steeper, open slope. Photo: S. Cannings.

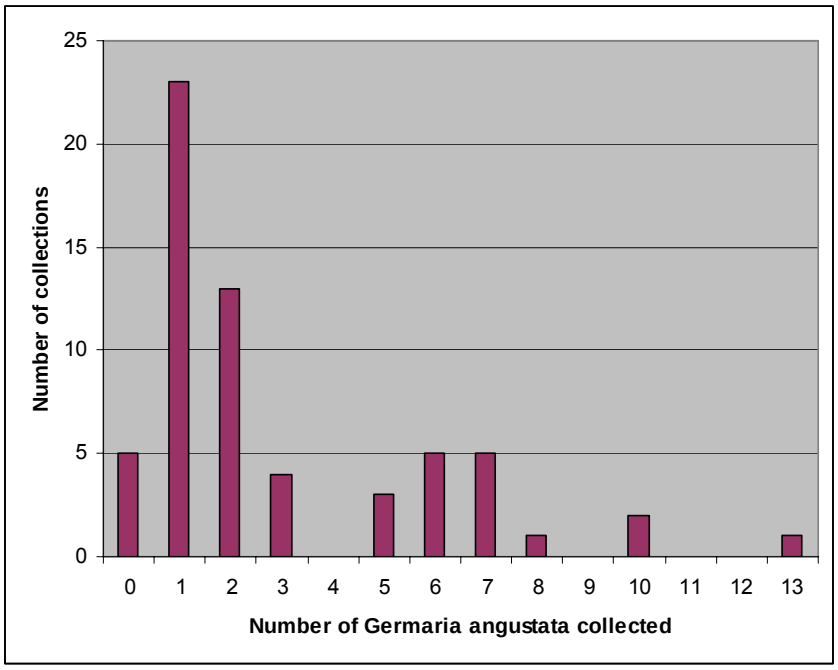

Figure 26. Frequency of 30-minute sample sizes of *G. angustata* specimens taken at sites where at least one specimen was captured on that day.

In summary there is solid evidence of recent habitat decline only at Carcross. However, natural succession at the Alsek dunes appears to be causing a decline in active sand movement there as well. It should be noted that these are the sites of the two largest populations of *G. angustata* known in Canada. Although there are threats in other locations (e.g., invasion of exotic plants), a future decline at those sites cannot be inferred at this time based on available evidence.

BIOLOGY

Little is known of the biology of this species; however, based on direct observations of its behaviour, phenology, and knowledge of other tachinids, some reasonable speculations of its life history can be made. Tachinid flies are parasitoids of the larvae of other insects, often moth caterpillars. The host of *G. angustata* is unknown.

Life cycle and reproduction

Adult *G. angustata* have been collected in the southern Yukon from 9 June to 23 July. In 2009, during a relatively intensive sampling season, the last flies were seen on July 22; however, that summer was hotter and drier than usual in June and July, so the flight season may go later in more moderate years. In coastal Europe the flight season is definitely longer, from late May to mid-August (Belshaw 1993; Herting 1960; Tschorsnig and Herting1994).

At Carcross, females of *G. angustata* fly low over the open sand, alight on single stems of grass (e.g., *Bromus pumpellianus*), walk to the base of each, and apparently lay an egg there (Polak 1989; D.M. Wood, pers. comm. 2008). At Whitehorse in 2009, flies were seen landing on stalks of *Elymus calderi* and running quickly up and down the stalk (S. Cannings, pers. obs.). The eggs probably hatch quickly into a first instar larva that waits for a host caterpillar to come by. Because of the egg placement at the base of grass stems, D.M. Wood (pers. comm. 2008) hypothesizes that the host of *G. angustata* is a cutworm larva (a moth in the family Noctuidae) that burrows in the sand during the day and comes to the surface at night to feed on the base of the grass.

A dune-inhabiting cutworm species that is found at Whitehorse and Carcross, and has a very similar global range to that of *G. angustata* is the Coast Dart, *Euxoa cursoria* (Hufnagel). *E. cursoria* larvae are generalist herbivores, feeding on a variety of grasses and forbs growing in sand (Don Lafontaine, pers. comm. 2008; De Prins 2005). Adult *E. cursoria* fly from late July to the end of the summer; the next generation overwinters as eggs or small larvae and begin feeding the following spring. Pupation takes place deep beneath the sand surface (Don Lafontaine, pers. comm. 2008; De Prins 2005).

The known hosts of two species of Eurasian *Germaria* are moths in the family Sesiidae (Richter 1992); however, this does not mean that *G. angustata* is likely to have a similar host (D.M. Wood, pers. comm. 2009). There are two species of sesiids known from the Yukon, but neither is specific to dunes (Lafontaine and Wood 1997, D. Lafontaine, pers. comm. 2009) and sesiids are not known to use grasses as hosts (G. Anweiler, pers. comm. 2010).

Physiology and adaptability

There is no direct information on physiology.

The flies are active in cloudy or sunny weather. The lower temperature limit for activity is not precisely known, but flies are definitely active on cloudy days when the temperature is about 14˚C. Activity probably increases with increasing temperature, but it is not possible to measure this using present data. The upper temperature limit is also unknown, but this would probably not normally be encountered by flies in Yukon dunes.

The flies are also active in the open dunes during very windy days, but a number have been seen congregating in the lee of small poplar trees on these days (Lee Mennell, pers. comm. 2009).

Adaptability may be considered limited, because *G. angustata* is restricted to areas of active dunes and sand blowouts; this narrow habitat niche is probably related to that of a specific moth host. On the other hand, this fly is able to live in a wide variety of dunes from moderate seaside climates in Europe to the subalpine zone in the continental climate of boreal North America.

Dispersal and migration

No information is available. These flies, although relatively small, are strong fliers, presumably capable of flights of a number of kilometres. They could also be blown greater distances by strong winds. However, there is no data on how often they leave the small dune areas in search of new habitat.

Interspecific interactions

No information is available.

POPULATION SIZES AND TRENDS

Sampling effort and methods

During the 2009 survey, most sites were sampled for at least 30 minutes between 10:00 am and 5:00 pm PDT in favourable weather (favourable weather is defined as any day warmer than 14˚ C and not raining, because cloud cover and wind did not appear to significantly inhibit fly activity). Surveyors walked in a meandering path through presumed good habitat for 30 minutes, catching every tachinid fly encountered. In larger sites, care was taken to continually sample 'new' habitat; in smaller sites, some retracing of steps or crossing of paths was necessary. Flies were caught with standard 15-inch aerial insect nets. Air temperature, cloud cover and, in some cases, wind velocity was recorded.

In 2008, Malaise traps were tested in sampling *Germaria* but, primarily because of constant wind, they proved unsuccessful. Traps not only blew down in the loose sand, but the wind vortices in the trap rendered them ineffective (Randall and Cannings 2008).

Abundance

Population size is difficult to estimate, but 30-minute searches in appropriate habitat resulted in samples of up to 13 specimens, usually 0 to 7 (Figure 26). Intensive inventories at Carcross in the 1980s resulted in up to 67 specimens being captured in 1-2 days, based on specimens at the Canadian National Collection. At the larger sites (e.g., Carcross, Sekulmun, and Alsek), one could speculate that more than 100, and perhaps several hundred flies are active in early July. Still, because appropriate habitat is limited, and because these are parasitic flies, the populations are undoubtedly quite small relative to most insect populations. Populations at some of the very small dunes around the city of Whitehorse may be maintained only by immigration from the two larger sites there.

Fluctuations and trends

No quantitative information is available, because earlier sampling programs were not done systematically, and did not record search effort. At Carcross, there is no qualitative evidence that the species is more or less abundant now than when it was sampled in 1987. D.M. Wood (pers. comm. 2009) believes that, like other tachinid flies, the populations can fluctuate dramatically from year to year. This was not evident, however, in sampling in 2008 and 2009.

Rescue effect

Rescue effect is probably nil. This species has yet to be discovered in Alaska, and even if it were found at the Kobuk or Nogahabara dunes in northwestern Alaska (Figure 4), it would not likely to be able to traverse the intervening 1000 or so kilometres and find a small dune in southwestern Yukon.

THREATS AND LIMITING FACTORS

Mapping of the aeolian sand deposits in the territory (Figures 6, 7) suggests that dunes were common in the Yukon and other northern landscapes during the last ice age (Stephen Wolfe, pers. com. 2008). However, most of these dunes have since been covered by boreal forest through natural succession. Succession is still occurring, but in active dune areas, blowouts can create new dune habitat at the same time other areas are lost to vegetation. Natural succession may be an increasing limiting factor at the Alsek dunes in Kluane National Park. There, the dunes are only about 150 years old, being formed following the flooding and subsequent catastrophic draining of Glacial Lake Alsek in the mid-19th century.

Invasive species are perhaps the greatest threat to Canada's *G. angustata* populations. Invasive dune stabilizers such as *Leymus angustus* (Altai Wild Rye) are beginning to encroach upon the Carcross Dunes area (B. Bennett, pers. comm. 2009). This species was first noted along a roadside in the Carcross village area in 1998, and is now more widespread in Carcross and along the South Klondike Highway from Lewes Lake, Yukon, south to the White Pass summit (BC-AK). At this time, it remains primarily confined to roadsides and has yet to invade the dunes (B. Bennett, pers. comm. 2009). *Melilotus alba* (White Sweet-clover) was first discovered in the Carcross dunes at the South Klondike Highway site in 2009, and is also beginning to invade the Dezadeash River corridor, possibly threatening the riverside sites in the Champagne area. This species could move downstream along the Dezadeash to the dunes along the Alsek River (B. Bennett, pers. comm. 2009). Based on knowledge of these invasive species in other jurisdictions, the effects of their establishment at the dunes could be severe in a very short time period (Conn *et al.* 2008).

Recreational use of ATVs and motorcycles is not a threat for populations in Kluane National Park, and for those in the dunes located on the east side of the Takhini River, as these sites are fairly inaccessible and are not visited often by humans. However, recreational use may pose a problem for other populations (west side of Takhini River, Carcross, Whitehorse, and Champagne), as they are more easily accessed.

Use of motorized recreational vehicles in the dunes can compact the sand, and remove and physically kill vegetation. This is of particular concern in the Carcross dunes, where off-road vehicle use is prevalent. There is anecdotal evidence that the grass and sedge vegetation on the main Carcross dune along the Klondike highway has declined since the great increase in off-road vehicle use in the last 30 or so years (Figures 10, 11, 23-25; see **Habitat trends** above). However, in some areas light ATV traffic may promote habitat for the moths and their Dune Tachinid predators.

Since 2007, a local tour company has been offering summer ATV excursions through the dunes along the Klondike Highway. Most of these are packaged tours for Holland America cruise passengers. It appears the tours generally follow the same route each time, limiting their impact to a small area. However, the impact these tours are having has not been studied. In addition to this commercial venture, individual citizens also use the dunes along the Klondike Highway on a regular basis for ATV and motorcycle recreation in summer (Figure 22). This use has apparently increased greatly over the last 25 years, but as yet, no monitoring program has been initiated to quantify this use and to understand its effects (Baikal Sedge Draft Recovery Strategy 2009

Snowmobiles are also used extensively in the Carcross dunes. It is estimated that up to 30 snow machines can be using the dunes during a winter weekend (Barrett, pers. comm., *in* Baikal Sedge Draft Recovery Strategy 2009). While the snow machines are using the dunes primarily when they are covered with snow, they may have a compacting effect. Snow may be quite shallow in certain areas at times, and snow machines may damage vegetation in these cases. Erosion of sand along the crest of dunes has been observed in Carcross (Baikal Sedge Draft Recovery Strategy 2009). Again, the impacts of these activities are unclear, and increased monitoring would be required to develop a clearer picture of the effects of snow machines.

PROTECTION, STATUS, AND RANKS

Legal protection and status

There is no existing protection for this species.

Non-legal status and ranks

Tachinid flies have not been ranked in the National General Status program. NatureServe ranks *Germaria angustata* G4G5 (apparently or demonstrably secure) globally; The Yukon Conservation Data Centre (Environment Yukon) ranks it S2 (Imperiled) in the Yukon.

Habitat protection and ownership

Two populations of *G. angustata* occur in Kluane National Park and Reserve: one at the confluence of the Dezadeash and Kaskawulsh rivers, and the other along the Slims River at the Bullion Creek confluence. The dune systems along the Takhini River are protected within Kusawa Territorial Park. The remaining locations are not specifically protected; their ownership is detailed in Table 1.

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

The report writer would like to thank Monty Wood, for introducing *Germaria angustata* to him in Carcross in 1987, and for introducing it to COSEWIC 20 years later. He also worked many hours identifying flies collected during the 2008 and 2009 inventories. Joachim Ziegler, of the Museum für Naturkunde in Berlin, freely shared his data on Eurasian *Germaria*.

Lea Randall, Lee Mennell, and Lori Schroeder provided wonderful field and lab assistance in 2008 and 2009. Other field assistants included Kaz Kuba, Fiona Schmiegelow and John Spence. Bruce Bennett and Jennifer Line offered botanical advice. Surficial geologists Jeff Bond and Stephen Wolfe greatly aided in the search for aeolian sand, and Stephen kindly offered his Yukon map. Jim O'Hara gave the report writer access to the Canadian National Collection, and arranged for Shannon Mahony to take the fly photographs in that institution. Don Lafontaine, Jean-François Landry, and Vazrick Nazari passed along their expert knowledge of dune moths.

John Meikle provided advice on dune locations, provided photographs, and searched out some remote sites.

INFORMATION SOURCES

Baikal Sedge Recovery Strategy. 2009. Proposed recovery strategy for the Baikal Sedge (*Carex sabulosa*) in Canada. [to be released soon].

Belshaw, R. 1993. Tachinid flies. Diptera: Tachinidae. Handbooks for the identification of British insects 10, Part 4a(i). Royal Entomological Society, London. 169 pp.

Conn, S., K.L. Beattie, M.A. Shephard, M. L. Carlson, I. Lapina, M. Hebert, R. Gronquist, R. Densmore, and M. Rasy. 2008. Alaska *Melilotus* invasions: distribution, origin, and susceptibility of plant communities. Arctic, Antarctic, and Alpine Research 40: 298-308.

COSEWIC. 2005. COSEWIC assessment and status report on the Baikal Sedge *Carex sabulosa* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 23 pp. Available at: www.sararegistry.gc.ca/status/status_e.cfm.

De Prins, W.O. 2005. Catalogue of the Lepidoptera of Belgium. Updated version of W.O. De Prins. 1998. Systematic Catalogue of the Lepidoptera of Belgium. Studiedocumenten van het K.B.I.N. 92: 1-236. Available online at the website of the Flemish Entomological Society: http://webh01.ua.ac.be/vve/Checklists/Lepidoptera/Introduction.htm. Accessed 25 August 2009.

Herting, B. and Á. Dely-Draskovits. 1993. Family Tachinidae. Pp. 118–458 *In* Soós, Á.and L. Papp, eds*.,* Catalogue of Palaearctic Diptera. Volume 13. Anthomyiidae – Tachinidae*.* Hungarian Natural History Museum, Budapest. 624 pp.

Johnson, E., and H.M. Raup. 1964. Investigations in southwest Yukon: geobotanical and archaeological reconnaissance. Papers of the Robert S. Peabody Foundation for Archaeology 6(1):1-198.

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

Lafontaine, J.D. and D.M. Wood. 1997. Butterflies and moths (Lepidoptera) of the Yukon. Pages 723-785 in H.V. Danks and J.A. Downes (Eds.), Insects of the Yukon. Biological Survey of Canada (Terrestrial Arthropods), Ottawa. 1034 pp.

Nazari, V., and J.-F. Landry. 2009. The Gnorimoschemini of Yukon. Unpublished report submitted to Canadian Wildlife Service, Environment Canada, Whitehorse Yukon. 29 pp.

O'Hara, J. 2008. World genera of the Tachinidae (Diptera) and their regional occurrence. Version 4. PDF document, 71 pages. Available online at:. http://www.nadsdiptera.org/Tach/Genera/Gentach_ver4.pdf. Accessed 25 August 2009.

O'Hara, J., and D.M. Wood. 2004. Catalogue of the Tachinidae (Diptera) of America North of Mexico. Memoirs on Entomology, International, vol. 18. Associated Publishers, Gainesville, FL.

Polak, M. 1989. The Carcross dunes: a relict Beringian habitat? BSc. Honors thesis. Department of Biology, Carleton University, Ottawa, Ontario. 50 pages.

Randall, L., and S. Cannings. 2008. Dune tachinid fly (*Germaria angustata* Zetterstedt) inventory, 2008. Unpublished report, NatureServe Yukon and Environment Yukon, Whitehorse. 14 pp.

Raper, C. 2007. Tachinid recording scheme, dedicated to recording UK tachinids. Online database, available at: http://tachinidae.org.uk/site/index.php. Accessed 1 May 2009.

Richter, V. 1992. Hosts of Palearctic species of *Germaria* R.-D. Tachinid Times 5: 3–4.

Tschorsnig, H.P. and B. Herting. 1994. Die Raupenfliegen (Diptera: Tachinidae) Mitteleuropas: Bestimmungstabellen und Angaben zur Verbreitung und Ökologie der einzelnen Arten. Stutt. Beitr. Naturk. (A) 506, 170 pp.

Wood, D.M. 1994. Relationships among Tachinidae of northern Europe, Siberia, and northwestern North America. Pages 247–248 *in* O'Hara, J.E. (editor), *Abstract Volume. Third International Congress of Dipterology. August 1994.* Guelph: 270 pp.

Ziegler, J. 2010. Revision of the genus *Germaria* Robineau-Desvoidy (Diptera, Tachinidae) from Greece, with descriptions of two new species. Deutsche Entomologische Zeitschrift 57: 43-57.

BIOGRAPHICAL SUMMARY OF REPORT WRITER

Syd Cannings is a Species at Risk Biologist in the Canadian Wildlife Service in Whitehorse. He received his MSc in Zoology at the University of British Columbia in 1978, studying, among other things, the physiological ecology of water boatmen. Following graduation, he became the curator of the Spencer Entomological Museum, the major insect collection at UBC. In that position, he began a series of insect surveys to the Yukon, from 1979 to 1990, in order to help compile data on the distribution of the insects in the territory for the book *Insects of the Yukon.* 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: A Natural History; The BC Roadside Naturalist; Geology of British Columbia; and The World of Fresh Water.

COLLECTIONS EXAMINED

The Canadian National Collection (Agriculture and Agri-Food Canada, Ottawa) was examined for specimens; these are detailed in Table 2. The collections of the Beaty Biodiversity Museum (Spencer Entomological Collection), University of British Columbia; and the Royal Ontario Museum were searched, but no specimens were found. The collection data for those specimens collected in 2008 and 2009, and held temporarily at the Canadian Wildlife Service collection in Whitehorse, Yukon, are presented in Table 3.