Species at Risk Act
Management Plan Series

Management Plan for the Dune Tachinid Fly (*Germaria angustata*) in Canada

Dune Tachinid Fly

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For copies of the management plan, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

Cover illustration: Dune Tachinid Flies, Carcross, Yukon. Photo © Maria Leung, used with permission.

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[1] www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of management plans for listed species of special concern and are required to report on progress within five years after the publication of the final document on the SAR Public Registry.

The Minister of Environment and Climate Change and Minister responsible for the Parks Canada Agency is the competent minister under SARA for the Dune Tachinid Fly and has prepared this management plan, as per section 65 of SARA. To the extent possible, it has been prepared in cooperation with the Government of the Yukon, First Nations Governments, and the Yukon Fish and Wildlife Management Board, as per section 66(1) of SARA.

Success in the conservation of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this plan and will not be achieved by Environment and Climate Change Canada, the Parks Canada Agency, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this plan for the benefit of the Dune Tachinid Fly and Canadian society as a whole.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

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

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The draft management plan was initially written by Maria Leung (private consultant) and Syd Cannings (Environment and Climate Change Canada, Canadian Wildlife Service (CWS) Northern Region). Joachim Ziegler, of the Museum für Naturkunde in Berlin, freely shared his data on Eurasian *Germaria*. Greg Pohl, Canadian Forest Service offered expert advice on possible moth hosts of the tachinid fly. Thomas Jung (Government of Yukon) offered comments on the drafts of the report, and he and Bruce Bennett contributed to the Threats Calculator assessment. The Yukon Conservation Data Centre provided information on occurrences from their database.

Executive Summary

In 2011, the Dune Tachinid Fly was assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as a species of Special Concern, largely because of its very restricted range and specialized habitat. It was added to Schedule 1 of the *Species at Risk Act* (SARA) in February 2017.

In North America, the Dune Tachinid Fly is only known from sand dunes in the southwestern Yukon. These consist of eight dune complexes: Carcross/Bennett Lake; Kusawa (upper Takhini River); Alsek River in Kluane National Park and Reserve; ’A’ąy Chù’ (Slims River) in Kluane National Park and Reserve; Sekulmun Lake; two, small, cliff-top dunes near Champagne; similar, small sand blowouts around Whitehorse; and one isolated ridge-top blowout southeast of the Sekulmun Lake dunes. In Eurasia, it is known from two distinct areas: one centred on Mongolia, and the other in Europe, where it is scattered in coastal and interior dune complexes.

The Dune Tachinid Fly is a parasitoid, requiring a host to complete development. It infects an early instar moth caterpillar, growing within its host, and eventually killing it upon pupation. To date, the host species in Canada is unknown, but likely candidate species would have overlapping distribution and feed at the base of grasses where Dune Tachinid Flies lay eggs.

The habitat is characterized by active or semi-stabilized dunes, typically with >60% sand and sparse vegetation. The vegetation community consistently includes grasses (some of which are presumably the food plants of its host moth), though no one species of grass is found at all occupied sites. Other plant species provide nectar for the adult flies’ energy needs.

The greatest threat facing the Dune Tachinid Fly is habitat encroachment and degradation. Current and proposed developments in Carcross have and will continue to alter existing habitat. Off-road vehicles (e.g. all-terrain vehicles, snowmobiles) repeatedly damage the vegetation community at some occupied sites. Displacement of existing plant community and stabilization by invasive species such as Altai Wild Rye compromise the natural disturbance regime that allows sand dunes to persist.

The objective of this management plan is to ensure the persistence of Dune Tachinid Flies at all extant sites in Canada (those known now and any newly located or rediscovered subpopulations in the future). Of the conservation measures identified, the highest priority is fostering collaboration with government, industry, land owners and other interested parties to find and implement suitable approaches for protecting habitat needs of the Dune Tachinid Fly. Research and surveys that provide a better understanding of the Dune Tachinid Fly’s life history and population dynamics would support the development of beneficial management practices.

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1. COSEWIC* Species Assessment Information

Date of Assessment: May 2011

Common Name (population): Dune Tachinid Fly

Scientific Name: *Germaria angustata*

COSEWIC 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.

Canadian Occurrence: Yukon

COSEWIC Status History: Designated Special Concern in May 2011.

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

2. Species Status Information

The Dune Tachinid Fly (*Germaria angustata*) has a global conservation status of Apparently Secure – Secure (G4G5). Its national status is Vulnerable (N3). Its status in the Yukon is also Vulnerable (S3) (NatureServe 2021). The species was listed as Special Concern under Schedule 1 of Canada's *Species at Risk Act* (SARA) in February 2017.

3. Species Information

3.1. Species Description

The Dune Tachinid Fly belongs to the Family Tachinidae (O'Hara 2016) within the Order Diptera (true flies). Adults are shiny black and bristly, measuring approximately 9 mm in length. As with other tachinids, the eyes are burgundy in colour, and the antennae have a small branch, the arista, made up of three segments called aristomeres. The Dune Tachinid Fly is distinguished from other North American tachinids by an inconspicuous first aristomere, an elongate and slightly curved second aristomere, and a third aristomere that is flattened from side to side, giving it a broader appearance in lateral view (Figure 1) (COSEWIC 2011).

Immature stages of the Dune Tachinid Fly have not been described.

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

The life history of the Dune Tachinid Fly is not well known, and is primarily inferred from other members of the tachinid family and from field observations. Tachinids are parasitoids[3] of arthropods[4]. Hosts of tachinids are almost exclusively insects, with moths and butterflies being the most common. Tachinids either deposit their eggs directly into their host, or lay eggs where larvae are likely to be in close proximity to their host. The larva then burrows into its host, feeding only on hemolymph at first, and then other body parts, including fat stores. During its early development, the tachinid larva avoids

[3] Parasitoids are animals that consume a single host while the host is still alive, and kill their host before they leave it.

[4] Arthropods are invertebrates that have an external skeleton and paired, jointed limbs—insects, spiders, crustaceans and their relatives.

damaging the host's vital organs and align its growth with that of its host, sometimes purposefully delaying its development to do so. The last-stage larva feeds voraciously and less discriminately, eventually killing and usually exiting the host before transforming into a pupa.

3.2. Species Population and Distribution

Most records for the Dune Tachinid Fly are from Eurasia, where it has been found in two distinct areas—Europe, and a part of central Asia, centred on Mongolia and including adjacent northern China and southern Siberia (Figure 2; COSEWIC 2011).

In North America, the Dune Tachinid Fly is known only from dunes in southwestern Yukon (Wood 1994; Polak 1989; COSEWIC 2011). Although it is difficult to estimate the percent of global population that occurs in Canada, it is likely less than 1 percent. Focused searches in North America outside of the Yukon yielded no records (Polak 1989). These searches were conducted at Lake Athabasca and the Great Sand Hills of Saskatchewan, and the Kobuk and Nogahabara dune complexes in western Alaska. In the Yukon, the species has been found at 13 individual sites (Table 1 and Figure 3), within 8 dune complexes in the southwestern Yukon: Carcross/Bennett Lake; Kusawa (upper Takhini River); three sites along the Alsek River in Kluane National Park and Reserve; 'A'äy Chù' (Slims River) in Kluane National Park and Reserve; Sekulmun Lake; two, small, cliff-top dunes near Champagne; similar sand blowouts around Whitehorse; and one isolated ridge-top blowout southeast of the Sekulmun Lake dunes (Yukon Conservation Data Centre 2021). The two southern sites along the Alsek River were discovered after the COSEWIC (2011) report was written (Yukon Conservation Data Centre 2021), so are not included in that document.

Any estimates of population abundance would be speculative, but in appropriate habitat, it can be fairly common. For example, in the 1980s, intensive inventory at a small portion of the Carcross site yielded 67 specimens within 1 to 2 days (data from Canadian National Collection; COSEWIC 2011).

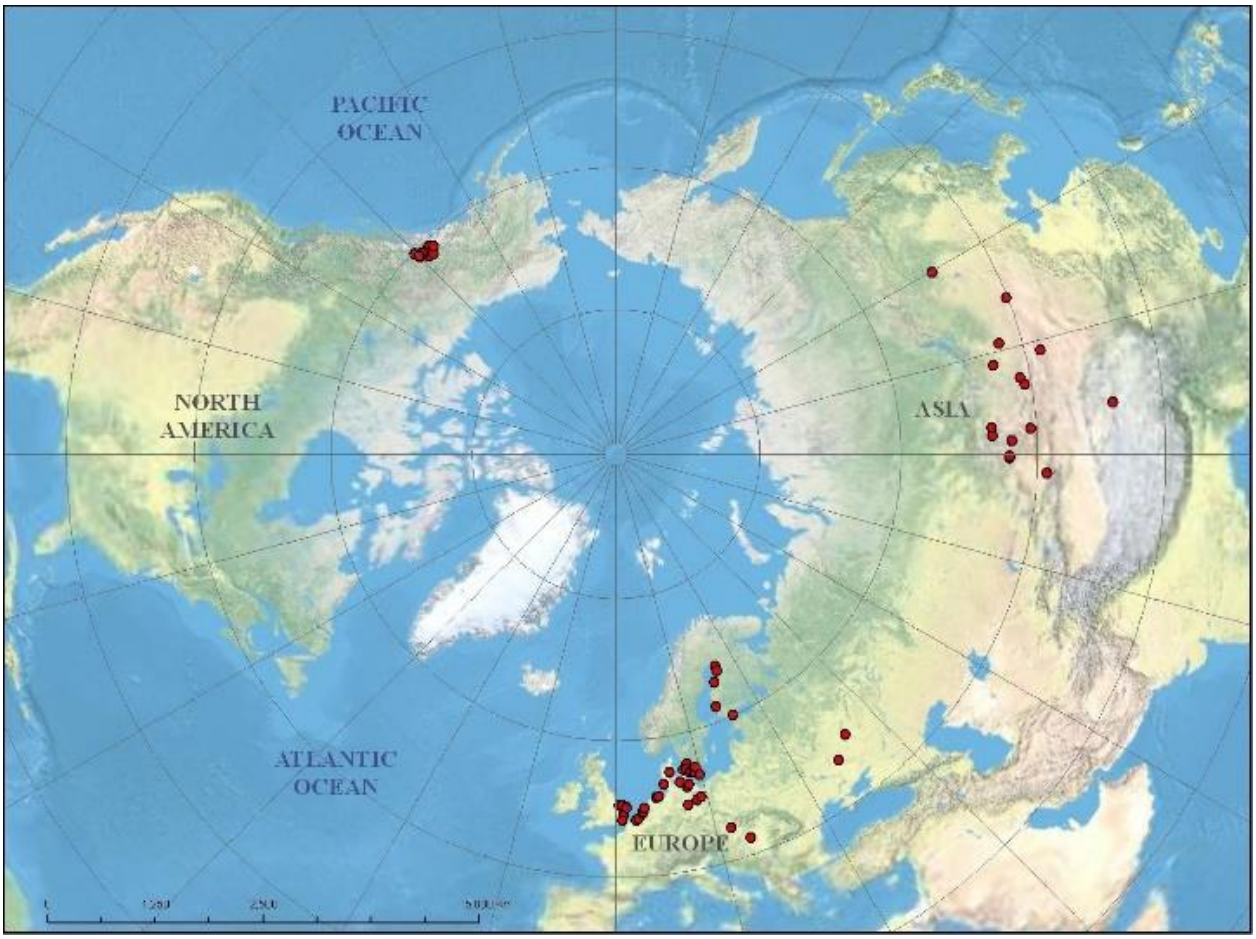

Figure 2. Global distribution of the Dune Tachinid Fly. Data from Joachim Ziegler (pers. comm. 2010) and Yukon Conservation Data Centre (2021).

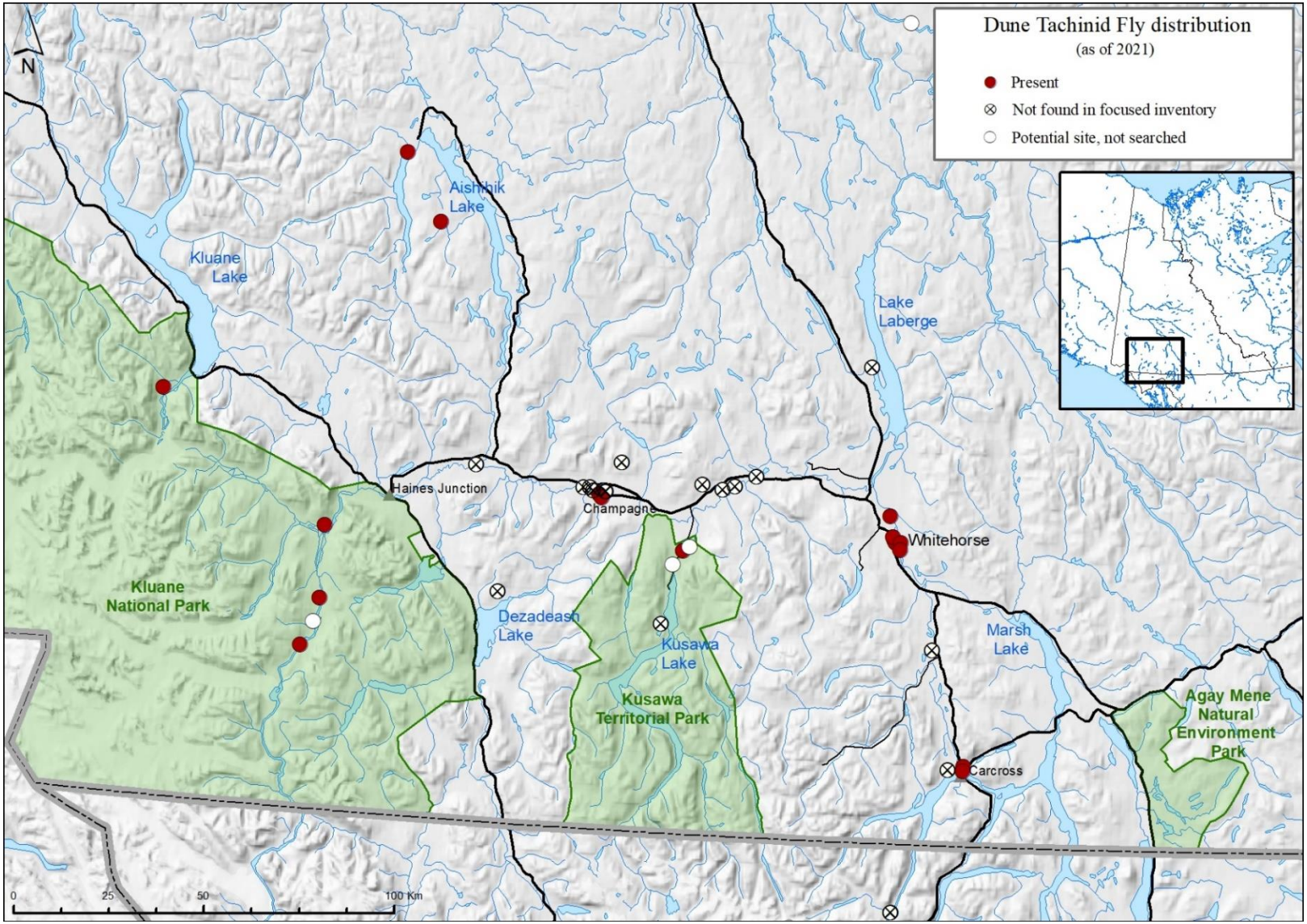

Figure 3. Known distribution (red dots) of the Dune Tachinid Fly in Canada.

Table 1. Known sites of the Dune Tachinid Fly in Canada. All sites are in the Yukon. Areas are approximations of suitable habitat. First Nations ownership; CTFN = Carcross-Tagish First Nation; CAFN = Champagne and Aishihik First Nations; KDFN = Kwanlin Dun First Nation. The two Alsek River 'lower' sites were discovered in 2018 (Yukon Conservation Data Centre 2021) and thus were not included in COSEWIC (2011).

Location	Latitude N	Longitude W	Elevation (m)	Land Ownership	Approx. area (ha)
Aishihik Lake, 12 km W	61.4053	136.3941	1220	Crown	0.1
Alsek River, upper	60.6698	137.8001	590	Parks Canada	50
Alsek River, lower 1	60.4980	137.7969	545	Parks Canada	1
Alsek River, lower 2	60.3843	137.0698	530	Parks Canada	1
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
'A'äy Chù' (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

3.3. Needs of the Dune Tachinid Fly

Dune Tachinid Flies live in active or semi-stabilized sand dunes between 660 m and 1220 m in elevation (Table 1). Occupied dunes in the Yukon are characterized as active dunes (areas of sand movement and accumulation) and blow-outs (areas where the wind is actively excavating sand) with sparse vegetation, where sand is being deposited but the dune is somewhat stabilized. The lake sites at Carcross and Sekulmun Lakes are oriented so that the prevailing southerly winds hit the beach with force, depositing the beach sand onto the dunes. At the various river sites, the river cuts through deposits that are either wholly composed of, 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.

The dunes typically have >60% open sand and a plant community that includes a scattering of grasses. Polak (1989) noted that Dune Tachinid Flies have been observed laying eggs on Pumpelly's Brome (*Bromus pumpellianus),* and inferred that the larva of its host moth probably eats grasses. No single grass species occurs at all sites, but Rocky Mountain Fescue (*Festuca saximontana*), Pumpelly's Brome, Purple Reedgrass (*Calamagrostis purpurascens* var*. purpurascens),* and Calder's Wild Rye (*Elymus calderi*) are frequent, and Slender Wild Rye (*E. trachycaulus*) is sometimes present (Appendix 1). Baikal Sedge (*Carex sabulosa,* listed as Special Concern under the *Species at Risk Act*), is a dominant feature of many of the sites, but the Dune Tachinid Fly is also found at a number of sites where Baikal Sedge is absent. Other frequent plant species include Pacific Wormwood (*Artemisia campestris),* Prairie Sagebrush (*A. frigida*), Siberian Aster *(Eurybia sibirica*), Field Horsetail (*Equisetum arvense*), Yukon Lupine (*Lupinus kuschei*), Northern Yellow Point-vetch (*Oxytropis campestris*), Gorman's Beardtongue (*Penstemon gormanii*), Lodgepole Pine (*Pinus contorta*), Balsam Poplar (*Populus balsamifera*), Trembling Aspen (*P. tremuloides*), Showy Jacob's-ladder (*Polemonium pulcherrimum*), Sticky Goldenrod (*Solidago simplex*), and Long-stalked Stitchwort *(Stellaria longipes*) (COSEWIC 2005; COSEWIC 2011; Appendix 1). Adult tachinids feed on nectar from a wide variety of flowers (O'Hara 2008), which may include some of these plant species.

The only globally documented host of the Dune Tachinid Fly is *Euzophera alpherakyella,* a snout moth (Family Pyralidae; Tschorsnig 2017). This host record comes from China (Tschorsnig 2017); *E. alpherakyella* is a Eurasian moth that does not occur in North America (Pohl et al. 2016) or in western Europe (Yepishin et al. 2020). The life cycle of this moth is poorly documented and its overwintering stage is unknown. Known hosts to other *Germaria* species are clearwing moths (Family Sesiidae) and other snout moths (Tschorsnig 2017). Likely candidate hosts for the Dune Tachinid Fly in the Yukon would be moths that inhabit sand dunes, have overlapping distributions with the tachinid fly, and have caterpillars that feed where the fly lays its eggs. Host species would also have young caterpillars developing during the same period that young Dune Tachinid Fly larvae are present. In the Yukon, Dune Tachinid Fly adults are active in June and July, and lay eggs at the base of grasses such as Pumpelly's Brome and Calder's Wild Rye (COSEWIC 2011). The most likely host is *Anerastia lotella*, a

snout moth belonging to the subfamily Phycitinae. It is quite common at the Carcross dunes (G. Pohl, pers. comm. 2017, 2018) and is known from grassland sites across North America from Alaska to the Great Lakes. Globally, it is found in most of Europe, western Russia, Asia Minor, Iran and western Turkestan. The larvae feed on graminoids and construct silken galleries around the stem base and roots. They are thought to overwinter in the larval stage. Caterpillars have been found in May and June (BOLD Systems 2014).

Until the identity of its host species is discovered, it is not possible to determine whether the distribution of the host species limits the distribution of the Dune Tachinid Fly. The primary candidate host species, *Anerastia lotella*, has a much wider distribution than the Dune Tachinid Fly.

4. Threats

4.1. Threat Assessment

The Dune Tachinid Fly threat assessment is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system. Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational). Limiting factors are not considered during this assessment process. For purposes of threat assessment, only present and future threats are considered. Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats are presented in the Description of Threats section.

With four separate threats rated as Low, the calculated overall threat impact is Medium.

Table 2. IUCN-CMP threats calculator assessment. The COSEWIC (2011) status report did not contain a threats calculator. This assessment builds on the threats discussed in that document (adding threats 1, 3, 4, 10, and 11), using the results from IUCN-CMP Threats Calculator meeting for Baikal Sedge, 14 January 2016 (COSEWIC 2016) and update meeting on 5 February 2021 (with Syd Cannings (Canadian Wildlife Service), Bruce Bennett, and Tom Jung (Environment Yukon)) as a guide.

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed threats
1	Residential & commercial development	Low	Small	Extreme	High	
1.1	Housing & urban areas	Low	Small	Extreme	High	Residential development in the Carcross dunes.
1.2	Commercial & industrial areas	Negligible	Negligible	Extreme	High	There is a residential/ commercial zone on dunes along shore of Bennett Lake.
1.3	Tourism & recreation areas	Negligible	Negligible	Extreme	Moderate	Potential; no active development proposals in dunes
3	Energy production & mining	Negligible	Negligible	Slight	High	
3.2	Mining & quarrying	Negligible	Negligible	Slight	High	Some sand quarrying occurs, especially in Whitehorse.
4	Transportation & service corridors	Negligible	Negligible	Extreme	Moderate	
4.1	Roads & railroads	Negligible	Negligible	Extreme	Moderate	Carcross Local Area Plan proposes a new access road to Carcross through the dunes.
6	Human intrusions & disturbance	Low	Restricted	Moderate	High	
6.1	Recreational activities	Low	Restricted	Moderate	High	All-terrain vehicles and snow machines compact sand and kill vegetation.

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed threats
7	Natural system modifications	Low	Large	Slight	High	
7.1	Fire & fire suppression	Unknown	Large	Unknown	High	Fire suppression increases risk/rate of dune stabilization
7.2	Dams & water management/use	Low	Small	Slight	Moderate	Proposed changes to Southern Lakes water storage; Bennett Lake could have higher water levels in late summer and fall, reducing sand movement into dunes.
7.3	Other ecosystem modifications	Low	Small	Slight	High	Stablization of dunes, especially at upper Alsek dunes (young dunes without a large supply of sand). As part of natural succession, native species colonize and stabilize dunes; this threat is scored here.
8	Invasive & other problematic species & genes	Unknown	Small-Restricted	Unknown	High	
8.1	Invasive non-native/alien species	Unknown	Small-Restricted	Unknown	High	Altai Wild Rye and White Sweet-clover encroaching dunes. Smooth Brome and Quackgrass also of concern.
10	Geological events	Negligible	Negligible	Extreme	Moderate-Low	
10.3	Avalanches, landslides	Negligible	Negligible	Extreme	Moderate-Low	There is a possibility of the Lowell Glacier surging and damming the Alsek River again (as it did in the 1850s). However, the resulting lake is unlikely to reach the main Dune Tachinid Fly sites at the confluence of the Kaskawulsh and Dezadeash Rivers, since the mass and depth of the Lowell Glacier has diminished considerably in recent decades.

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

[a] **Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment timeframe (e.g., timing is insignificant/negligible or low as threat is only considered to be in the past); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

[b] **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible < 1%).

[c] **Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible < 1%; Neutral or Potential Benefit ≥ 0%).

[d] **Timing** – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

4.2. Description of Threats

IUCN Threat 1 Residential and commercial development (Low)

Current and proposed development in Carcross will continue to alter existing habitat. A residential development has begun in the Carcross dunes (Figure 4), and there is a residential/commercial zone along the shoreline of Bennett Lake adjacent to this development (Figure 4; Yukon Energy, Mines and Resources 2018). This development and development zone, however, are small relative to the entire dune area.

IUCN Threat 3 Energy production and mining (Negligible)

Removal of sand from sites inhabited by the Dune Tachinid Fly could compromise habitat integrity. There are many aggregate quarries close to major transportation routes, but there is insufficient detail in publicly available documents to understand the extent of sand removed from aggregate quarries, some of which are open to public use. At present, there is no extraction at known Dune Tachinid Fly sites.

IUCN Threat 4 Transportation and Service Corridors (Negligible)

A second road access to Carcross is in the planning stages; this route is intended to help with traffic flow in and out of the community, especially during emergencies (Figure 4). The Local Area Plan states that “the recommended alternate access route will impact the dune system” and “the significance of these impacts will be considered in discussion with community members” (Yukon Government and Carcross/Tagish First Nations 2013). However, the area affected by this proposal is small relative to the size of the entire dune system.

IUCN Threat 6 Human intrusion and disturbance (Low)

Use of motorized vehicles compacts sand and damages vegetation. This is of particular concern in the Carcross dune complex, where the use of all-terrain vehicles (ATVs), motorcycles and snowmobiles are prevalent. There is anecdotal evidence that the grass and sedge vegetation on the main Carcross dune along the Klondike highway has declined since the increase in off-road vehicle use in the last 30 years. During this period, up to 12% of the Carcross dune complex has lost vegetation due to motorcycle and ATV activity (COSEWIC 2011). A small portion of the damage is attributed to guided ATV excursions through the dunes along the Klondike Highway. However, the damage is confined to a small area as vehicles generally follow the same route each time (COSEWIC 2011).

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

Recreational use of ATVs and motorcycles is not a threat for occurrences in Kluane National Park and Reserve, and for the occurrences in the dunes located on the east side of the Takhini River, as these sites are fairly inaccessible and are not often visited by humans (COSEWIC 2011). 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.

IUCN Threat 7 Natural system modifications (Low)

The persistence of habitat for the Dune Tachinid Fly is dependent on natural disturbance.

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

The natural movement of beach sand onto the Carcross dunes may be reduced by the proposal to augment hydro power. In order to increase capacity for generating electricity through the winter, Yukon Energy is proposing to accumulate water behind the Lewes Control Structure by 30 cm more than is currently permitted. This means that in a year with a naturally high water level from snow melt and rainfall, the shoreline at Bennett Lake would see little difference due to the increase in allowable water accumulation. However, in a year with low water levels, the water level would be artificially raised to the allowable level by closing the Lewes Control Structure. This would begin as early as mid-August (Yukon Energy 2020). The resulting increased inundation of the shoreline sand would reduce the amount of sand blowing into the sand dunes.

Research on dunes suggests that this habitat was common in the Yukon and other northern landscapes during and immediately following the last ice age (Wolfe et al. 2011, COSEWIC 2011). Most of these dunes have since been covered by forest through natural succession. Where there isn't a constant supply of fresh sand that can feed the dune-making process, this natural stabilization may affect the long-term viability of Dune Tachinid Fly populations.

IUCN Threat 8 Invasive and other problematic species and genes (Unknown)

Invasive plant species that compromise the dynamics of the active sand dunes or displace existing plant communities reduce the quality and quantity of suitable habitat for the Dune Tachinid Fly. Invasive dune stabilizers such as Altai Wild Rye (*Leymus angustus*) are encroaching the Carcross Dunes area (COSEWIC 2016). Altai Wild Rye 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). As of 2010, Altai Wild Rye remained primarily confined to roadsides and had yet to invade any dunes (COSEWIC 2011). Other graminoid invaders include Smooth Brome (*Bromus inermis*) and Quackgrass (*Elymus repens*); both grow well in sandy soils and have colonized the highway corridor adjacent to the dunes (Bruce Bennett, pers. comm. 2018). White Sweet-clover (*Melilotus albus*) was first discovered in the Carcross dunes at the South Klondike Highway site in 2009, and is also invading 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 (COSEWIC 2011). 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).

As part of natural succession, native vegetation is apt to colonize sand dunes and reduce their size. Many dunes in the Yukon have already been covered by boreal forest (COSEWIC 2011). This process will be accelerated if the climate trends for precipitation in the Yukon continue as projected. In the last 50 years, there has been a 6% increase in annual precipitation. Of this, the greatest increase has occurred in summer (Streicker 2016). The Alsek dunes in Kluane National Park and Reserve are particularly vulnerable to stabilization due to succession. The site is only about 150 years old, being formed following the flooding and subsequent catastrophic draining of Glacial Lake Alsek in the mid-19th century (COSEWIC 2011).

IUCN Threat 10 Geological events (Negliglible)

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

IUCN Threat 11 Climate Change and Severe Weather (Unknown)

Increased precipitation and warmer temperatures over the last 60-80 years (Streicker 2016) may have allowed Trembling Aspen to invade grassland habitat (Conway 2012; Conway and Danby 2014), and thus may contribute to increasing the speed of dune stabilization, especially at smaller sites.

Ryan et al. (2022) summarize the latest projections for the south-central Yukon. Mean annual precipitation in the region is projected to increase by 20-22% by the 2050s; winter, spring and summer precipitation is projected to increase 11-26%, and fall precipitation is projected to increase 35-36%. Precipitation by snow is expected to increase 11-12%. Temperatures are projected to increase 2.5-3.1°C in the summer and

fall, and 2.1-2.6°C in the winter and spring. The number of frost-free days is expected to rise by 24-26 days, a 22-24% increase.

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

Climate warming has also caused the retreat of the Kaskawulsh Glacier, which has allowed the Kaskawulsh River to 'steal' the watershed of the 'A'äy Chù' (Slims River), and increase greatly in size (Shugar et al. 2017). This has caused some flooding and erosion near the dunes at the confluence of the Dezadeash and Kaskawulsh rivers, but is unlikely to reduce the size of these dunes, at least in the short term. Increased glacial melt may increase this threat in the future, however. The lower Alsek River dunes are on a raised bench next to the river, and are somewhat protected from increased erosion in the short term.

Figure 4. Carcross development area. Dunes underly most of the land in this map, and are especially active near the shoreline of Bennett Lake. Modified from Yukon Energy, Mines and Resources (2018).

5. Management Objective

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

Continuing presence of stable numbers of Dune Tachinid Flies at known sites both implies and requires continued habitat integrity[5]. Because the Dune Tachinid Fly is threatened primarily by loss and degradation of habitat (COSEWIC 2011), this objective will be reached through management or mitigation of the threats to its habitat (see Table 2 and Section 4.2).

Absolute abundance is not easily estimated, but an index of relative abundance can be derived using repeatable, time-limited surveys in appropriate habitat at each site. At some sites, continued habitat integrity may require mitigation measures to allow ongoing dune movement and reduce the disturbance of suitable habitat features (e.g. dune grasses). Zoning and other land use planning measures could allow for natural dune development in key areas.

6. Broad Strategies and Conservation Measures

6.1. Actions Already Completed or Currently Underway

Inventory:

- 2008-2009: Focused surveys of dunes throughout the southwest Yukon by Canadian Wildlife Service, with the assistance of Yukon Government staff. These surveys were designed to discover new sites, to document habitat, and to provide a preliminary indication of the abundance of Dune Tachinid Flies at each site.
- 2017-2018: Parks Canada and Canadian Wildlife Service conducted brief surveys along the Kaskawulsh and Alsek Rivers.

Research:

- 2018: Small study of the biology of the fly (primarily searching for host moths) undertaken at Carcross through a contract from Canadian Wildlife Service (Leung 2018).

Stewardship:

- 2015-present. White sweet-clover has been pulled and mowed from the Dezadeash River boat launch by Parks Canada and the Village of Haines Junction. Parks Canada has conducted an invasive species inventory down the river in 2019. Sweet-clover was found 500m downstream from the boat launch and is now actively managed (C. Wong, pers. comm. 2021).
- 2021: New management plan for Kluane National Park and Reserve: Protection has been increased for the ’A’ąy Chù’ (Slims River) dunes and the lower Alsek dunes; they have been zoned as a Zone 1, where access is only permitted for park operations or research (C. Wong, pers. comm. 2021). The upper Alsek dunes have been zoned as Environmentally Sensitive Area which allows

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

protection but also access which can enhance public awareness about dune complexes.

6.2. Broad Strategies

In order to achieve the management objective, conservation measures are organized under three broad strategies (numbers refer to Conservation Measures Partnership (CMP) (2016) Conservation Actions Classification (v2.0).

1. Land/water management
3. Awareness raising
8. Research and monitoring

6.3. Conservation Measures

Table 3. Conservation Measures and Implementation Schedule.

All measures are ongoing, from the publication of this Management Plan.

Conservation Measure	Priority[a]	Threats or Concerns Addressed
CMP Strategy 1: Land/water Management		
1.1 Identify and prioritize sites that are most at risk of habitat degradation and loss. 1.2 Collaborate with Yukon and First Nations governments, industry, land owners, and other interested parties to find suitable approaches for maintaining habitat of the Dune Tachinid Fly. 1.3 Follow-up on and re-evaluate management and stewardship initiatives aimed at maintaining suitable habitat.	High	Loss/degradation of dunes; Threats 1, 3, 4, 6
CMP Strategy 3: Awareness Raising		
3.1 Raise public awareness and promote conservation of the Dune Tachinid Fly and its habitat. 3.2 Develop communication tools to educate land users on how to minimize their impact on the habitat of the Dune Tachinid Fly.	High	Public support for conservation
CMP Strategy 8: Research and Monitoring		
8.1 Assess population size. 8.2 Develop standard survey protocol 8.3 Conduct standard, repeated surveys in occupied sites to assess population trends.	Medium	Status of species at sites
8.3 Identify the host species; document its life cycle, food plants and other key life requisites. 8.4 Study the life cycle of the Dune Tachinid Fly and microhabitat needs. Identify the components of active sand dunes that are essential for the species to persist.	Medium	Needs of species; Threats 7, 8, 11

[a] "Priority" reflects the degree to which the measure contributes directly to the conservation of the species or is an essential precursor to a measure that contributes to the conservation of the species. High priority measures are considered those most likely to have an immediate and/or direct influence on attaining the management objective for the species. Medium priority measures may have a less immediate or less direct influence on reaching the management objective, but are still important for the management of the population. Low priority conservation measures will likely have an indirect or gradual influence on reaching the management objective, but are considered important contributions to the knowledge base and/or public involvement and acceptance of the species.

6.4. Narrative to Support Conservation Measures and Implementation Schedule

CMP Strategy 1: Land/Water Management

Given the specialized and limited extent of the habitat needed by the Dune Tachinid Fly (active dunes with grasses), habitat management and stewardship are central to maintaining habitat integrity: mitigating threats and restoring degraded habitat. In this context, degraded habitat is defined as dunes that have either been stripped of their grass component through overuse, or have become stabilized by native or exotic vegetation. Collaboration with governments, land owners, and industry is required to devise and implement strategies that would minimize habitat degradation and protect occupied sites. Methods for restoring and enhancing habitat could offset habitats that are already irreparable. Follow up would be required for such strategies to determine whether they are working as intended or require further intervention.

Dune conservation and stewardship would benefit not just the Dune Tachinid Fly, but all dune specialist species, including the SARA listed Baikal Sedge (*C. sabulosa*).

CMP Strategy 3: Awareness Raising

Small flies like the Dune Tachinid Fly are difficult to observe and identify, and because of this, the public is often unaware of their existence or the impact land use activities can have on the species' habitat. Increasing public awareness on the habitat needs of Dune Tachinid fly is one method of reducing habitat damage from recreational activities. This could be achieved with signage at sites with highest risk of damage. However, combining these efforts with those aimed at other dune specialist species (such as the Baikal Sedge) and general dune conservation likely would be more successful. In particular, meeting with organizations representing off-road vehicle users would be valuable.

It will also be important to have informative materials available to land users, managers and developers to serve as references for mitigating threats in land use planning. Such materials can be in the form of booklets or webpages.

CMP Strategy 8: Inventory and Research

A standardized protocol is needed to ensure that comparisons among sites and over time can be made. Such a protocol would designate the timing and search effort required to detect the Dune Tachinid Fly at previously unsurveyed sites. As well, use of the protocol at sites of known occupation would provide estimates of relative abundance. Surveying new sites and documenting habitat parameters (e.g. vegetation community) will increase knowledge on species distribution and will refine our understanding what constitutes high quality habitat for Dune Tachinid Fly. To assess how well the management objectives are being met, occupied sites will need to be monitored regularly to determine whether there are changes in population size.

The life history, ecology and habitat requirements of the Dune Tachinid Fly are currently poorly understood. Identifying and understanding the needs of the Dune Tachinid Fly's host species is critical to understanding its requirements. It is unknown whether the Dune Tachinid Fly is limited by the availability of its host. Understanding the particular components of the active sand dune that the Dune Tachinid Fly uses will provide insight on what management practices are most beneficial in maintaining suitable habitat. Developing methods to create suitable habitat may be applicable in situations where offset is needed to compensate irreversibly damaged habitat.

7. Measuring Progress

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

- Completion of a risk assessment to identify sites that are at most risk of habitat degradation.
- Where they are needed to maintain habitat integrity, explicit management or mitigation measures are in place at sites occupied by Dune Tachinid Fly. Monitoring surveys are in place to track the effectiveness of these mitigation measures, by measuring the disturbance (e.g. all-terrain vehicle use) at selected sites.
- Growth or lack of change in population size indicate that conservation actions are effective in maintaining the population. Population trends will be determined by repeated, timed surveys of Dune Tachinid Flies at representative sites.
- Repeated reconnaissance at all known sites (and any additional sites discovered in the future) indicate the species persistence throughout its Canadian range.
- Outreach products have been developed and distributed to governments and the public.

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Appendix A: Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[6]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[7] (FSDS) goals and targets.

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

This management plan will clearly benefit the environment by promoting the conservation of the Dune Tachinid Fly and, at some overlapping sites, the Baikal Sedge. The potential for the plan to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this plan will clearly benefit the environment and will not entail any significant adverse effects. The reader should refer to the following sections of the document in particular: description of the species' habitat and biological needs, ecological role, and limiting factors; effects on other species; and the implementation actions.

[6] www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html
[7] www.fsds-sfdd.ca/index.html#/en/goals/