COSEWIC
Assessment and Status Report

on the

Foothill Sedge
Carex tumulicola

in Canada

SPECIAL CONCERN
2022

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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

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COSEWIC
Assessment Summary

Assessment Summary – December 2022

Common name
Foothill Sedge

Scientific name
Carex tumulicola

Status
Special Concern

Reason for designation
This perennial species is characteristic of mesic to moist meadows and associated Garry Oak woodlands unique to the semi-Mediterranean climate of south-eastern Vancouver Island, British Columbia. The Canadian population consists of a few thousand mature individuals and although sixteen subpopulations have recently been discovered, many have very low numbers of plants. The primary threat to the species is encroachment by non-native herbs and native and non-native trees and shrubs. Due to changes in the application of assessment criteria, the species is no longer severely fragmented, which reduced the at-risk status.

Occurrence
British Columbia

Status history
Designated Endangered in April 2008. Status re-examined and designated Special Concern in December 2022.

COSEWIC
Executive Summary

Foothill Sedge
Carex tumulicola

Wildlife Species Description and Significance

Foothill Sedge is a grass-like plant that spreads through underground runners and forms large patches of leaves. The inconspicuous flowers are borne on the ends of stalks that are longer than the leaves and, like the leaves, often lie flat. Foothill Sedge is part of a suite of species that, in Canada, are found only in Garry Oak and associated ecosystems on southeastern Vancouver Island and adjacent islands.

Distribution

Foothill Sedge is found west of the Cascade and Sierra Nevada mountains, from Vancouver Island to southern California. In Canada, it is found mainly in the Victoria area, with an outlying subpopulation near Nanaimo. Less than 1% of the species' global range is in Canada.

Habitat

Throughout its range, Foothill Sedge is found in a variety of prairie, meadow, and open woodland habitats. In Canada, most plants are found in mesic meadows and Garry Oak woodland.

Biology

Foothill Sedge is a long-lived, slow-growing perennial. The species remains green through most of the year, with most growth occurring in fall and spring. Flowers are produced in June and July and seeds are ripe by late summer. Seeds germinate the following spring. Dispersal mechanisms are unknown but may include movement of seeds by birds or small mammals. The species does not appear to be an important forage species for herbivores.

Population Sizes and Trends

The total Canadian population is estimated at between 1660 and 3514 mature individuals. Approximately 85% of all plants are found in one subpopulation and several subpopulations consist of only one or two plants. In the last 10 years, declines in the number of mature individuals have been observed at 7 of the 23 known subpopulation sites in Canada. Other subpopulations appear stable, although they may have experienced historical declines.

Threats and Limiting Factors

The potential habitat for Foothill Sedge has been substantially reduced through urbanization. These habitats are among the most endangered in Canada and have been reduced to a tiny fraction of their original extent. At remaining sites, Foothill Sedge is threatened by an overgrowth of woody vegetation, including non-native and native shrubs and trees. Lack of fire and the introduction of non-native shrubs have resulted in the conversion of meadows to thickets and forests. Human intrusions through mowing and recreational activities continue to threaten plants at some sites. The species appears to be limited by low rates of seedling establishment and the small size of many subpopulations.

Protection, Status, and Ranks

Foothill Sedge is listed as Endangered under the *Species at Risk Act*. It is not protected under any provincial legislation. Many subpopulations are located in parklands that have prohibitions against harm to native plants. It is not ranked as at risk in Washington, Oregon, or California.

TECHNICAL SUMMARY

Carex tumulicola

Foothill Sedge

Carex tumulicole

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

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	10 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Observed decline
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations, whichever is longer, up to a maximum of 100 years]	1%–5% within the next 20 years
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years or 3 generations, whichever is longer, up to a maximum of 100 years].	1%–10% loss estimated over the last 30 years based on habitat loss and degradation and observed loss of plants from some subpopulations
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years or 3 generations, whichever is longer, up to a maximum of 100 years].	1%–15% loss projected and suspected over the next 30 years; upper end assumes no ongoing restoration or protection measures
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any period [10 years or 3 generations, whichever is longer, up to a maximum of 100 years], including both the past and the future.	1%–15% loss projected and suspected over the next 30 years
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. Partly; threats can be mitigated with the participation of all relevant jurisdictions and landowners; historical loss of habitat is not clearly reversible b. Yes c. No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	1676 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	124 km² known; unlikely to exceed 500 km²

Is the population “severely fragmented” i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	No. a. Although most subpopulations comprise a small number of mature individuals with no evidence of recent recruitment, the majority of the population occurs in one viable subpopulation. b. Distance between habitat patches may be within the species’ potential range of dispersal but there is no evidence of dispersal taking place.
Number of “locations”* (use plausible range to reflect uncertainty if appropriate)	At least 23, based on the rate of woody plant encroachment at the subpopulation sites
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Unknown; several subpopulations contain only one or two individuals and could easily be lost
Is there an [observed, inferred, or projected] decline in number of “locations”*?	Unknown; several locations contain three or fewer individuals and could easily be lost
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, observed decline in quality
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of “locations”*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	**N Mature Individuals**
Albert Head	1–10
Braefoot	1–10
Christmas Hill	6–10
Cedar Hill Park	51–53
Colwood Fuel Depot	1
Cuthbert Holmes Park	1–3
Francis/King Regional Park	3–10
Harewood Plains	3
Lochside Trail	5–10

* See Definitions and Abbreviations on COSEWIC website for more information on this term.

Mount Tolmie	9–20
Naden	5–8
Panama Hill	20–60
Playfair Park	8–15
Prospect Lake Rd	5–15
Queenswood	2
Rithet's Bog Conservation Area	4–10
Rocky Point	1374–3048
Sidney Island north	101
Sidney Island south	5–20
Summit Park	3–10
Swan Lake Nature Sanctuary	3–10
Uplands Park	40–70
Work Point	9–15
Total	1660–3514

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, whichever is longer, up to a maximum of 100 years, or 10% within 100 years]?	N/A

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species?
Yes. Threat impact: **Medium**

i. Invasive and other problematic species, genes, and diseases: Invasive non-native species [Low threat impact]
ii. Natural systems modification: Other ecosystem modification [Low threat impact]
iii. Human intrusion and disturbance: Recreational activities [Low threat impact]
iv. Human intrusion and disturbance: Work & other activities [Low threat impact]
v. Transportation and service corridors: Roads and railroads [Low threat impact]

What additional limiting factors are relevant?
Apparently long generation times, small size of most subpopulations increases potential for inbreeding, and the low rate of seedling establishment.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Secure
Is immigration known or possible?	Possible

Would immigrants be adapted to survive in Canada?	Likely
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?[+]	Yes
Are conditions for the source (i.e., outside) population deteriorating?[+]	Yes
Is the Canadian population considered to be a sink? [+]	No
Is rescue from outside populations likely?	Unknown

Data Sensitive Species

Is this a data sensitive species?	No

Status History

COSEWIC: Designated Endangered in April 2008. Status re-examined and designated Special Concern in December 2022.

Status and Reasons for Designation

Status: Special Concern	**Alpha-numeric codes:** Not applicable.
Reasons for designation: This perennial species is characteristic of mesic to moist meadows and associated Garry Oak woodlands unique to the semi-Mediterranean climate of south-eastern Vancouver Island, British Columbia. The Canadian population consists of a few thousand mature individuals and although sixteen subpopulations have recently been discovered, many have very low numbers of plants. The primary threat to the species is encroachment by non-native herbs and native and non-native trees and shrubs. Due to changes in the application of assessment criteria, the species is no longer severely fragmented, which reduced the at-risk status.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. The rate of reduction in the number of mature individuals over the past three generations (30 years) and the suspected rate over the next three generations are below the threshold for Threatened.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. EOO of 1676 km^2 and IAO of 124 km^2 are below the threshold for Endangered. There is a continuing observed and suspected decline in mature individuals, but the population is not severely fragmented, occurs at >10 locations, and does not experience extreme fluctuations.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Population may meet threshold for Endangered, as the plausible range of individuals (1660–3514) may be less than 2500. However, C1 is not met as a decline of 1%–5% over the next two generations (20 years) is below the threshold of 20% for a population of 250–2500 individuals. C2a(i) is not met as one subpopulation has many more than 250 mature individuals. C2a(ii) may apply, as one subpopulation is 86%–88% of the total population and due to uncertainty in counting mature individuals, it is possible, but not likely plausible, that this subpopulation is 95% or more of the Canadian population.

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

Criterion D (Very Small or Restricted Population): Not applicable. Population estimate of greater than 1660 mature individuals exceeds thresholds for D1, and population is not vulnerable to rapid and substantial decline required for D2. Moreover, thresholds for the number of locations and IAO are surpassed.
Criterion E (Quantitative Analysis): Not applicable. Analysis not conducted.

PREFACE

Since the publication of the previous status report (COSEWIC 2008), many new subpopulations (or sites) of Foothill Sedge have been discovered in Canada. These discoveries have significantly increased the number of known subpopulations and estimated total population. However, many of these subpopulations also face considerable threats, and declines in the number of individuals have been observed at some subpopulation sites in the short time since their discovery. Several subpopulations, including the largest ones in Canada, are now subject to restoration efforts, which are reducing the threats to Foothill Sedge.

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 (2022)

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

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

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

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

Environment and Climate Change Canada
Canadian Wildlife Service
Environnement et Changement climatique Canada
Service canadien de la faune
Canada

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

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Scientific name**:** *Carex tumulicola* Mackenzie

Common names**:** Foothill Sedge, Split Awn Sedge, Berkeley Sedge

Family**:** Cyperaceae, sedge family

Major plant group: Monocot

Synonyms: None

Foothill Sedge was described in 1907 near San Francisco, California (Mackenzie 1907). The species is within the subgenus *Vignea*, Section *Phaestoglochin* of the large genus *Carex* (Ball 2020; Villaverde *et al.* 2020). The common name Berkeley Sedge is used in horticulture and has been applied to this species and to similar European species.

Morphological Description

Foothill Sedge is a grass-like perennial from short rhizomes, forming loose tufts from 20 cm to more than 150 cm in diameter (Figure 1) (see Douglas *et al*. 2001 and Ball 2020 for more descriptive details). The stems are up to 80 cm long and may be upright or decumbent. Each stem bears 3 to 10 spikes (Figure 2). Each spike bears both male and female flowers, with the males above the females (androgynous).

Within the species' known Canadian range and habitat, there is no other *Carex* with androgynous spikes. Hood's Sedge (*Carex hoodii*) has androgynous spikes and occurs nearby, but it is found in higher-elevation meadows and bears its spikes in congested heads without the leaf-like bracts of Foothill Sedge.

Figure 1. A patch of Foothill Sedge surrounded by grasses. Photo by Canadian Forces Base Esquimalt.

Figure 2. Inflorescence of Foothill Sedge. Photo by Canadian Forces Base Esquimalt.

Population Spatial Structure and Variability

The population genetic structure of Foothill Sedge in Canada has not been studied. Most extant subpopulations are separated by few too many kilometres of unsuitable habitat and it is unlikely that there is currently significant genetic exchange. Because all *Carex* pollen is airborne, it is theoretically possible that wind-aided transport of gametes could be acting to link isolated sites to each other, although the chances of this occurring on a regular basis seem remote. Because potential habitat for Foothill Sedge was formerly extensive in the Victoria area, it is likely that these subpopulations were more connected in the past. The subpopulation in the Nanaimo area is the most isolated from others and is unlikely to have genetic exchange with any other Canadian subpopulations.

Designatable Units

A single designatable unit is recognized. This species has no infraspecific taxa or ecotypes and the entire Canadian range is within a single COSEWIC national ecological area.

Special Significance

Foothill Sedge is a characteristic species of a very specific habitat in British Columbia: the mesic to moist meadows and associated Garry Oak (*Quercus garryana*) woodlands unique to the semi-Mediterranean climate of southeastern Vancouver Island. Foothill Sedge can be abundant in these habitats and is one of the few native grasses or sedges that may have dominated these systems prior to the arrival of non-native European forage species (Chappell and Caplow 2004). Because of this, it could potentially be an important species in restoration of degraded habitats or in meadow reconstruction projects. Foothill Sedge is one of the species planted on the Vancouver Convention Centre green roof (Sutton *et al.* 2012).

DISTRIBUTION

Global Range

Records of Foothill Sedge throughout its range have been documented by Calflora (2020), the Consortium of California Herbaria (2020), and the Consortium of Pacific Northwest Herbaria (2020). Foothill Sedge is found throughout coastal California, including the Coast Mountains, as far south as the Channel Islands. The range extends inland to parts of the Central Valley and western side of the Sierra Nevada Mountains. It occurs throughout western Oregon but becomes more sparsely distributed north of the Columbia River. The northernmost group of subpopulations includes Whidbey Island, the San Juan Islands, and the Canadian subpopulations described in the next section (Figure 3).

A photograph of a specimen originally identified as Foothill Sedge from northeastern California was reviewed by the report writers and appears to have been misidentified (specimen accession number HSC-48189). Likewise, several specimens from Idaho appear to be other species (Legler pers. comm. 2020; Zika pers. comm. 2020). The species is ranked Historical (SH) in Idaho, based on a single record from 1931 (Corbin pers. comm. 2021; Kinter pers. comm. 2021). Records from mainland Washington north of Olympia include one specimen from Seattle that was believed by the collectors to have been planted (specimen accession number WTU-394005) and two records from Snohomish King County that were reviewed by the report writers and identified as *Carex deweyana sensu lato* (specimen accession numbers WTU-407253 and WTU-407254). The review of specimens was based on photos available from the Consortium of Pacific Northwest Herbaria database (2020).

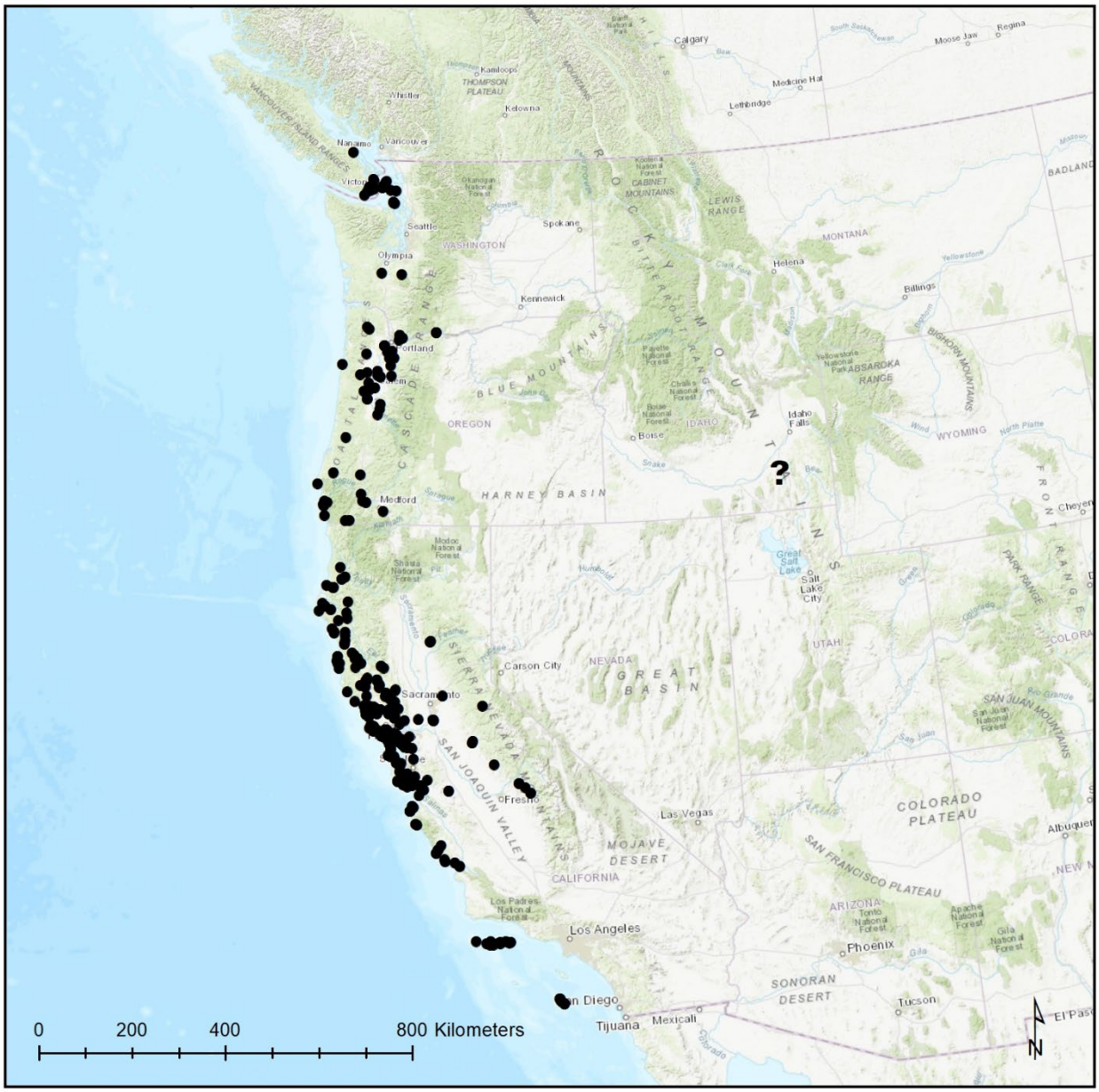

Figure 3. Global distribution of Foothill Sedge. Question mark indicates uncertain status in Idaho.

Canadian Range

In Canada, Foothill Sedge has only been found along the southeast coast of Vancouver Island and on one adjacent island. Most known subpopulations occur in the Greater Victoria area, with one apparently isolated subpopulation near Nanaimo (Figure 4). Less than 1% of the species' global range is in Canada.

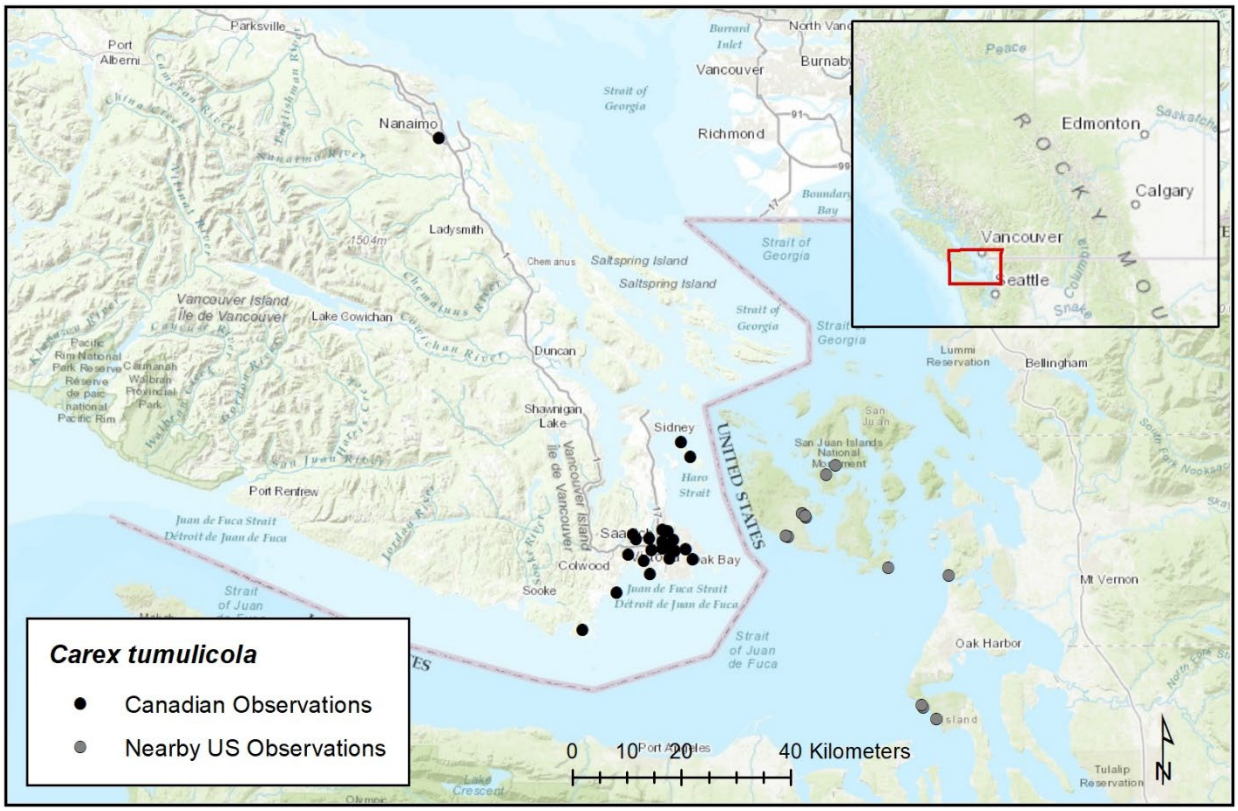

Figure 4. Distribution of Foothill Sedge in Canada and adjacent USA.

Extent of Occurrence and Area of Occupancy

Foothill Sedge was first collected on Vancouver Island in 1999 and is now known from 23 subpopulations in Canada. Subpopulations are concentrated in the Victoria area, extending from Metchosin in the west, northeast to Sidney Island, with an apparently disjunct subpopulation in Nanaimo. The total extent of occurrence (EOO) is 1676 km^2. The index of area of occupancy (IAO) based on 4 km^2 grid squares is 124 km^2. The actual area of habitat the species physically occupies is much smaller.

Search Effort

The Victoria area is one of the most thoroughly investigated areas for vascular plants in British Columbia. However, sedges and grasses have historically received less attention than other vascular plant groups and fewer people have the knowledge or interest required to make a meaningful contribution to the search effort. Intensive surveys for Foothill Sedge began with its discovery in 1999. Subsequent surveys for the species brought the number of known sites in Canada to four (Ceska and Ceska 2000).

Approximately 10 days of fieldwork specifically targeting Foothill Sedge were carried out in 2003 and 2004 during peak flowering season. Using aerial photographs and topographic maps, potential habitat areas in the vicinity of known sites at Metchosin, Victoria, and Nanaimo were identified. The search sites included all of Trial Island and portions of Chatham Island, Rocky Point, Uplands Park, East Sooke Park (Aylard Farm), Mt. Tolmie Park, the University of Victoria campus, Rithet's Bog, Albert Head, Christmas Hill, Little Saanich Mt., Mill Hill, Fort Rodd Hill National Historic Site, Joan Point/Harmac, and Harewood Plains (COSEWIC 2008).

Following the assessment of Foothill Sedge as Endangered (COSEWIC 2008), interest in finding the species increased greatly, resulting in the discovery of several subpopulations in small municipal parks. These areas were likely missed in previous surveys because of small land area and, in some cases, the poor condition of native plant communities. Subpopulations were also discovered on private lands through surveys associated with development applications. The listing of the species under the *Species at Risk Act* spurred surveys on federal lands. All Department of National Defence lands of Canadian Forces Base Esquimalt were surveyed intensively, resulting in the discovery of several subpopulations and generating more detailed information on Canada's largest subpopulation at Rocky Point.

With each discovery, knowledge of the species' habitat improved, facilitating subsequent surveys. Surveys have now covered the majority of potential habitat in the Victoria area that is accessible and apparently suitable. Surveys have included not just high-quality oak woodlands and meadows, but also disturbed meadows and old field sites. It is likely that additional subpopulations remain undiscovered on private lands where surveyors have not had access. Survey coverage is much less complete north of the Victoria area.

Most subpopulations have been verified extant in the last one to three years (Table 1).

Table 1. Canadian subpopulations of Foothill Sedge: Sizes, observations, ownership, and trends

Subpopulation	N Mature Individuals	Most Recent Observation	Ownership	Trend
Albert Head*	1–10	2019	Department of National Defence	Observed decline[1]
Braefoot	1–10	2013	Private	Observed decline
Christmas Hill	6–10	2014	Private	Apparently stable
Cedar Hill Park	51–53	2020	Municipal Park	Observed decline
Colwood Fuel Depot	1	2019	Department of National Defence	Apparently stable
Cuthbert Holmes Park	1–3	2016	Municipal Park	Observed decline
Francis/King Regional Park	3–10	2020	Regional Park	Apparently stable
Harewood Plains*	3	2009	Private	Apparently stable

Subpopulation	N Mature Individuals	Most Recent Observation	Ownership	Trend
Lochside Trail	5–10	2020	Private/Municipal Right of Way	Apparently stable
Mount Tolmie*	9–20	2020	University of Victoria/ Municipal Park	Observed decline
Naden	5–8	2019	Department of National Defence	Apparently stable
Panama Hill	20–60	2016	Municipal Park	Apparently stable
Playfair Park	8–15	2020	Municipal Park	Apparently stable
Prospect Lake Rd	5–15	2017	Private	unknown
Queenswood	2	2020	University of Victoria	Observed decline
Rithet's Bog Conservation Area	4–10	2020	Municipal Park	Observed decline
Rocky Point*	1374–3048	2020	Department of National Defence / Indian Reserve	Apparently stable
Sidney Island north*	101	2019	Parks Canada	Apparently stable
Sidney Island south	5–20	2020	Private	unknown
Summit Park	3–10	2014	Municipal Park	Apparently stable
Swan Lake Nature Sanctuary*	3–10	2012	Municipal Park	Apparently stable
Uplands Park*	40–70	2020	Municipal Park	Apparently stable
Work Point	9–15	2019	Department of National Defence	Apparently stable
Total	1660–3514			

* Subpopulation in previous status report (COSEWIC 2008)

[1] Observed decline describes sites where plants that were noted by the Conservation Data Centre (BC Conservation Data Centre 2020a) or observed by the writers in a previous survey were no longer present in the most recent survey. Details in numbers of individuals and apparent cause are provided under **Threats**.

HABITAT

Habitat Requirements

Throughout its range, Foothill Sedge is found in upland prairies, dry to moist meadows, forest openings, and open woodlands (Hitchcock *et al.* 1969; Wilson *et al*. 2008). It is described as a facultative upland species, meaning that it is usually found in upland habitat but sometimes in wetlands (United States Department of Agriculture 2020).

In Canada, Foothill Sedge is restricted to the dry coastal lowland zone of southeastern Vancouver Island. The region is characterized by a sub-Mediterranean climate with warm, dry summers and mild, wet winters. Within this region, some individuals of Foothill Sedge occur in subxeric conditions (*sensu* Pojar *et al.* 1991) in soil pockets among bedrock outcrops. Other plants grow in subhygric conditions, where water is near the soil surface through much of the winter and associated species include wetland obligates. However, Foothill Sedge in this region is most commonly found in submesic to mesic Garry Oak woodlands and associated meadows (Figure 5). Tree cover at occupied sites ranges from absent to near 100% but is usually less than 50%. The most commonly associated tree

species is Garry Oak, but Douglas-fir (*Pseudotsuga menziesii*) and other species are common at the sites of a few subpopulations. Shrub cover ranges from absent to high and most commonly includes Nootka Rose (*Rosa nutkan*a) and Common Snowberry (*Symphoricarpos albus*). Associated herbaceous plants commonly include native species, such as other sedges (*Carex* spp.), California Oatgrass (*Danthonia californica*), California Brome (*Bromus carinatus*), and blue camas (*Camassia* spp.), as well as non-native species such as Colonial Bentgrass (*Agrostis capillaris*), annual bromes (*Bromus* spp.), Orchard Grass (*Dactylis glomerata*), and Velvet Grass (*Holcus lanatus*). A small percentage of plants (<2%) occur in other habitats, including along roads or trails in conifer forest and in highly disturbed former meadows where there may be no other native plant species.

Figure 5. Typical habitat of Foothill Sedge in Canada – mesic meadow and associated Garry Oak woodland at Rocky Point. Photo by Natural Resources Canada.

Habitat Trends

At the time of European colonization, open meadows and savannahs had an extensive distribution on southeastern Vancouver Island (Pemberton 1860). These habitats were referred to as “prairie” or “plains” and were the dominant vegetative cover over much of the Victoria area (Lea 2011). Conversion of these habitats to agriculture was very rapid. The deep-soiled, mesic meadows preferred by Foothill Sedge would have been preferred for farming and likely experienced the fastest and most severe declines. Following the large-scale conversion of meadow and savannah habitat to agriculture, there has been large-scale conversion of agricultural lands to residential and commercial uses. The decline of Garry Oak ecosystems in Canada between 1800 and 1997 is estimated at 90% (Lea 2006). Declines have continued since 1997 but have not been estimated. The extent of mesic, deep-soiled Garry Oak habitat preferred by Foothill Sedge in the Victoria area is estimated to have declined by 99.5% between 1800 and 1997 (Lea 2006). Most remaining examples are small and highly fragmented within a largely urbanized landscape.

Non-native herbaceous plants that compete for light, water, and nutrients are now ubiquitous in remnant Garry Oak ecosystems (Fuchs 2001). Non-native shrubs and trees transform meadows into thickets and form a dense understorey in oak woodlands, blocking light from reaching the ground and eliminating the original native flora.

Garry Oak ecosystems evolved with frequent fire. Pollen records show that fire has been common on the landscape of southern Vancouver Island for at least 9000 years (Brown and Hebda 2002). These fires maintained the open structure of Garry Oak ecosystems by reducing the density of trees and impeding the growth of shrubs. With Euro-Canadian settlement, fire was largely excluded from the landscape. In the absence of naturally occurring fire, large areas of meadow and oak woodland rapidly transformed into conifer forest (Gedalof *et al.* 2006). Losses of the mesic habitats preferred by Foothill Sedge have been more pronounced than losses of Garry Oak ecosystems more generally (Gedalof *et al.* 2006; Hoffman *et al*. 2019). Declines in the extent and quality of Garry Oak ecosystems as a result of conifer and shrub invasion continue today (see **Threats**).

BIOLOGY

There is little published information available on the biology of Foothill Sedge. The sections below include the writers’ own observations and information that has been published on other *Carex* species.

Life Cycle and Reproduction

Foothill Sedge seeds require a period of cold stratification to break dormancy, and therefore germinate naturally in spring (Broadlick and Bakker 2020). In nursery or garden settings, plants may flower in their second summer (Boyer pers. comm. 2020; Fisk pers. comm. 2020). Wild plants likely take longer to mature. Flowers are produced in late spring or early summer and seeds are ripe by late August. Vegetative growth is observed in fall,

spring, and early summer. Plants generally remain green through the summer drought, even as co-occurring grasses senesce. Individual plants spread slowly through rhizomes, forming discrete patches of foliage, or tussocks (Figure 6). In nursery or garden settings, with supplemental watering, fertilization, and freedom from competition, the diameter of tussocks increases at a rate of 5–10 cm per year (Boyer pers. comm. 2020; Fisk pers. comm. 2020). Wild plants likely grow more slowly. Wild plants range from 20 cm to more than 150 cm in diameter, representing estimated minimum ages of 4 to 30 years. The estimated average age of mature wild plants is at least 10 years, based on the average size of the plants. The species is likely long-lived, and some individual plants do not appear to have changed in size over 10 years of field observations (Miskelly pers. obs.). Seedlings and immature plants are apparently absent from most Canadian sites.

Figure 6. A large individual of Foothill Sedge lying flat, surrounded by upright Sweet Vernal Grass (*Anthoxanthum odoratum*). Photo by Natural Resources Canada.

It is not known how long the seeds of Foothill Sedge remain viable in the soil, although some Carex species have been shown to form persistent soil seed banks (Nariyasu et al. 2001). Wild-collected seeds have high rates of viability (Fisk pers. comm. 2020).

Physiology and Adaptability

There is no published information on the physiology of Foothill Sedge. The species shows a great deal of adaptability and can persist, although not necessarily thrive, in a range of moisture regimes and light levels. It also displays tolerance to a range of stressors. Foothill Sedge survives grass fires with no apparent reduction in either the size or density of individual patches (NRCan unpubl. data). It has a high tolerance to mowing, although repeated mowing may have caused reductions at some sites (see **Threats**). It is also tolerant of light to moderate trampling (but see **Threats**). Attempts to transplant wild plants, or outplant nursery stock, have had mixed results. At Rocky Point, several plants were transplanted into apparently suitable habitat within 50 m of wild plants. Some of these transplants appear healthy two to three years later, while others did not survive (NRCan unpubl. data). At Playfair Park, the original subpopulation has been augmented by outplanting container-grown plants. Many of these plants established well and are growing and producing seed, although it is unknown whether any of this seed has produced new progeny (O'Brien pers. comm. 2018). At least two restoration or meadow-creation projects in the Victoria area also include plants established from outplanted container-grown stock. These plants are growing and producing seed, although no new seedlings have yet been observed (Miskelly pers. obs.).

Dispersal and Migration

Some *Carex* species disperse over very long distances, apparently through transport by birds (Escudero *et al*. 2010), while other *Carex* are dispersed over relatively short distances by ants (Handel 1976). Dispersal by small mammals over short distances is also possible (see **Interspecific Interactions**). The seeds of Foothill Sedge do not show any apparent adaptations to transport by wind, water, or ants.

The species has shown some ability to colonize new areas in Canada. At Rocky Point, Victoria, a few individuals of Foothill Sedge grow directly on the roadbed where roads have been built through otherwise unsuitable habitat. Foothill Sedge has apparently been able to disperse at least a few hundred metres from the original habitat to colonize the light gaps created by the roadways.

Interspecific Interactions

Foothill Sedge appears to have a high tolerance to grazing pressure. On Sidney Island, grazing pressure by introduced Fallow Deer (*Dama dama*) was very high at the time that Foothill Sedge was discovered there. Foothill Sedge did not appear significantly grazed and was still able to produce seed in that setting. On San Juan Island, Foothill Sedge was one of the only native plants to survive at the margins of a large native prairie area severely overgrazed by European Rabbits (*Oryctolagus cuniculus*) (Miskelly pers. obs.).

The seeds of *Carex* species are, in general, rich in stored food and are occasionally eaten by wildfowl and other vertebrates (Booth 1950; Holt and van der Valk 2002). Entire seed heads of Foothill Sedge are sometimes removed by small mammals. Townsend's Vole

(*Microtus townsendii*) is suspected to be the browser based on its abundance at such sites. It is unknown whether these seeds are consumed immediately, or whether some may be cached and whether this could represent a dispersal mechanism.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Because Foothill Sedge is a rhizomatous species, it is not always possible to determine the number of individuals. In nursery or garden conditions, the plants expand symmetrically from the point of germination. Many wild plants also occur as discrete, symmetrical tussocks or turfs that appear to represent single individuals (Figure 6). These range from 20 cm to more than 150 cm in diameter. In those instances where plants formed discrete tussocks, each tussock was generally considered to represent a single individual. This is similar to the approach used for mosses, where a discrete patch or cushion is considered a single individual (Bergamini *et al.* 2019). When continuous cover of Foothill Sedge occurs in asymmetrical shapes or over large areas, determining the limits of individuals is not possible. These occurrences could represent single plants that have spread asymmetrically because of environmental conditions, single plants that have spread over large areas before partially dying or fragmenting, multiple plants that coalesced, or any combination of these possibilities. Where counting the number of discrete individuals is not possible, a conservative estimate is made based on a range that includes the expected minimum and maximum number of individuals that could have produced the observed growth pattern. At larger sites where data have been collected using multiple methods over longer time frames, a higher level of uncertainty in the number of individuals is reflected in a larger estimated range. This is particularly true of Rocky Point, the subpopulation with the greatest number of individuals.

Abundance

An estimated 1660–3514 mature individuals of Foothill Sedge occur in Canada, distributed among 23 known subpopulations (Table 1). The largest subpopulation is at Rocky Point (1374–3048 individuals), representing approximately 85% of the total Canadian population. No other subpopulation is believed to contain more than 100 individuals. Several subpopulations appear to consist of only 1 or 2 individuals.

Individuals of Foothill Sedge that have been outplanted into natural areas were not included in estimates of abundance. This is consistent with COSEWIC guidelines, as it remains unknown whether these outplanted individuals are contributing to the persistence of the greater Canadian population (COSEWIC 2018). Examples are two sites in the Victoria area where Foothill Sedge has been included in meadow-creation projects (Miskelly pers. obs.). These projects seek to convert areas of non-native field to native vegetation. The plantings are at most five years old and the associated plant communities are highly unstable. Also excluded from estimates for the same reason were plants that have been outplanted at Playfair Park to augment the natural population.

Fluctuations and Trends

Because Foothill Sedge is a slow-growing, long-lived species, it is unlikely that there are significant fluctuations in the number of individuals within any subpopulation. No significant fluctuations have been observed in the subpopulations that have been subject to regular observation. These subpopulations have either declined in response to threats or have remained apparently stable (Table 1).

As described in **Habitat Trends** above, the subpopulations at many sites may have been largely displaced during the past century and at the end of the century before by rapid agricultural conversion and the disruption of cultural burning practices, resulting in the spread of trees and shrubs into formerly open meadow habitat (see **Threats**). The species may have historically declined when large areas of potential habitat were destroyed for residential and commercial development. However, because the presence of the species in Canada went unnoticed until the 1990s, there is no historical information about its abundance or distribution.

The number of known Foothill Sedge subpopulations in Canada has increased substantially since the first status report was written. This is a reflection of increased survey effort and increased knowledge of graminoids among naturalists and professional biologists. There is no evidence, however, that the number of subpopulations or abundance of the species has actually increased since the last status report. All discoveries of new subpopulations include well-established, mature plants.

In 7 of the 23 known subpopulations, loss of individuals has been observed in the last 10 years (Table 1). Apparent causes of decline are described under **Threats and Limiting Factors**.

Rescue Effect

Foothill Sedge is abundant and widespread on San Juan Island, 17 km east of the nearest Canadian subpopulations (Miskelly pers. obs.). This distance is comparable to the distance between some subpopulations in the Victoria area. Therefore, movement of seeds between Washington and BC is considered possible. However, based on the lack of young plants in the Canadian population, there is no evidence of rescue actually occurring.

THREATS AND LIMITING FACTORS

Threats

Direct threats to Foothill Sedge were assessed following the IUCN-CMP (International Union for Conservation of Nature – Conservation Measures Partnership) unified threats classification system (see Salafsky *et al*. 2008 for definitions and Master *et al*. 2012 for guidelines). The process consists of assessing impacts for each of 11 main categories of

threats and their subcategories, based on the scope (proportion of population exposed to the threat over the next 10-year period), severity (predicted population decline within the scope during the next 10 years or 3 generations, whichever is longer), and timing of each threat. The overall threat impact is calculated by taking into account the separate impacts of all threat categories and can be adjusted by the species experts participating in the evaluation. The overall threat impact for Foothill Sedge is considered to be “medium” (Appendix 1), corresponding to an anticipated decline of between 3% and 30% over the next three-generation period.

Invasive and Other Problematic Species, Genes, and Diseases: Invasive Non-native / Alien Species [IUCN Threat 8.1 – Low impact]

The impact of non-native species is second only to that of habitat loss as a cause of species declines throughout the world (D’Antonio and Vitousek 1992; Myers and Bazely 2003).

Non-native shrubs and trees are present at the sites of most Foothill Sedge subpopulations in Canada. These non-native species can convert meadows into thickets and form a dense understorey in oak woodlands, preventing light from reaching the herbaceous flora at ground level. The most widespread species of concern are Scotch Broom (*Cytisus scoparius*), One-seed Hawthorn (*Crataegus monogyna*), Himalayan Blackberry (*Rubus armeniacus*), and Laurel Daphne (*Daphne laureola*). Scotch Broom is present at many sites and has represented a significant threat to Foothill Sedge at Rocky Point, Uplands Park, Naden, and Panama Hill. At the first three of these, Scotch Broom is controlled as part of ongoing restoration programs and is no longer an immediate threat. The species would likely become a threat again if these restoration programs were discontinued in the future. One-seed Hawthorn apparently eliminated a patch of Foothill Sedge at the Rithet’s Bog Conservation Area sometime between 2008 and 2013 and the species was subsequently believed to be extirpated from that site (Parks Canada Agency 2013). Later, additional patches of Foothill Sedge were found nearby, but all are now threatened by One-seed Hawthorn. The entire Panama Hill subpopulation, one of the largest in Canada, is threatened by increasing cover of One-seed Hawthorn. At many other subpopulation sites, this non-native species is present and could pose a future threat. Laurel Daphne is very abundant at the Albert Head subpopulation site and formerly grew over the occurrence of Foothill Sedge. The resulting shade caused the Foothill Sedge to decline in vigour and flowering and seed production stopped. Removal of the Laurel Daphne resulted in Foothill Sedge producing more leaves and once again flowering and setting seed.

Other species are problematic at single sites. For example, Gorse (*Ulex europaeus*) is abundant at Rocky Point. This species forms very dense thickets and produces a large amount of litter. When an established Gorse thicket is removed, there is typically no trace of the original meadow vegetation remaining. Sites at Rocky Point where Gorse thickets persist or have been removed have a low density of Foothill Sedge compared with surrounding habitat. English Ivy (*Hedera helix*) is common in the habitat of Foothill Sedge at Mount Tolmie and Cedar Hill Park. At both subpopulation sites, Foothill Sedge has persisted only in a narrow strip along foot paths, where either trail maintenance or occasional trampling precludes a dense cover of ivy.

Natural Systems Modifications: Fire and Fire Suppression – Suppression in Fire Frequency/Intensity [IUCN Threat 7.1 – Negligible impact] & Other ecosystem modification [IUCN Threat 7.3 – Low impact]

Prior to European settlement of Vancouver Island, natural and human-initiated fires played an important role in the maintenance of the region's dry Douglas-fir forests and Garry Oak savannahs (Turner and Bell 1971; Roemer 1972; MacDougall *et al.* 2004). While the average fire return interval in the Coastal Douglas-fir zone is estimated to be between 100 and 300 years (Agee 1993), First Nations used frequent, low-intensity fires to maintain good hunting conditions and an open stand structure favourable to important staple foods such as camas (*Camassia* spp.) and other wild root crops (Turner 1999; Fuchs 2001). Regular burning slowed the succession of native shrubs such as Nootka Rose and conifers such as Douglas-fir, while ensuring a continuous supply of safe sites for the germination and establishment of herbaceous meadow plants. First Nations fire management practices may have also played an important role in the development and fertility of soils by ensuring the steady release of organic nutrients into the upper soil horizon. Pollen and charcoal records show that fire has been common on the landscape in the Victoria area for at least 9000 years (Pellatt *et al*. 2001) and that for at least the last 2000 years, fire was part of Indigenous land management practices (Brown and Hebda 2002). The use of fire by Indigenous people was an annual occurrence that continued into the early years of Euro-Canadian colonization in the Victoria area (Fort Victoria Journal 1846–1850). Over the last 150 years, fire suppression has led to encroachment of woody shrubs and Douglas-fir into many formerly open areas, altering community composition and structure (Fuchs 2001; MacDougall *et al*. 2004; Gedalof *et al*. 2006; Lea 2006; Hoffman *et al*. 2019). The severity of this threat varies from site to site. However, it is present at most sites and has the potential for large population-level effects, due to altering habitat suitability over a large area.

Infilling of oak woodland by Douglas-fir is a threat to Foothill Sedge at Albert Head, Francis/King Regional Park, Mount Tolmie, and Rocky Point. Expansion of native shrub thickets into formerly open habitats is a threat at Cedar Hill Park, Christmas Hill, Francis/King Regional Park, Mount Tolmie, Rithet's Bog Conservation Area, Rocky Point, Swan Lake Nature Sanctuary, and Uplands Park. In the last 10 years, increases in native woody vegetation have apparently resulted in, or contributed to, the loss of Foothill Sedge individuals at Cedar Hill Park, Mount Tolmie, and Rithet's Bog Conservation Area. At Rocky Point, a 4-ha meadow containing an estimated 50 individuals of Foothill Sedge lost

approximately one third of its area to Nootka Rose encroachment in a 10-year period. Nootka Rose spread over the area occupied by an estimated 18 individuals of Foothill Sedge. These plants were not likely to survive without intervention. The habitat around this meadow includes several hectares of continuous Nootka Rose thicket. This thicket likely replaced Foothill Sedge habitat and eliminated individuals in the recent past.

On eastern Vancouver Island, Garry Oak and associated ecosystems have been invaded by non-native plants to such a degree that exotic species now comprise 59% to 82% of the total herbaceous cover (Roemer 1995; Erickson 1996). The proportion of introduced species in Garry Oak meadows increased from an estimated 25% of the total in 1972 to 40%–76% of the total in 1995 (Roemer 1995).

Most Foothill Sedge subpopulations in Canada occur in meadows dominated by non-native grasses. Competitive interactions appear to vary according to the species of non-native grass and the site. For example, at Panama Hill, Foothill Sedge is found in areas dominated by Colonial Bentgrass but absent from co-occurring patches of Reed Canarygrass (*Phalaris arundinacea*) (Miskelly, pers. obs.). At Rocky Point, Foothill Sedge patches appear to resist competition from annual bromes (mostly *Bromus hordeaceus*). At Playfair Park, however, Foothill Sedge was first detected as mature plants only after restoration actions reducing the abundance of the annual bromes was undertaken (O'Brien pers. com.). This suggests that the species was already present but suppressed by non-native grasses. In contrast, many individuals of Foothill Sedge at other subpopulation sites grow in meadows dominated by non-native grasses but seem to form discrete patches without ingress by the grasses (Figure 6). The almost complete lack of small (i.e. young) individuals of Foothill Sedge in Canadian subpopulations suggests that competition with grasses may be significantly limiting current recruitment.

Human Intrusion and Disturbance: Recreational Activities [IUCN Threat 6.1 – Low impact]

Foothill Sedge occurs alongside walking paths at Cedar Hill Park, Cuthbert Holmes, Francis/King Regional Park, Mount Tolmie, Panama Hill, Queenswood, Rithet's Bog Conservation Area, Swan Lake Nature Sanctuary, and Uplands Park. Many of these plants appear to be remnants of larger individuals that have been overtopped by shrubs and survive only along the edge of the path where trampling or trail maintenance controls shrub growth. These plants would be eliminated if trails were widened and would also be threatened if trampling or trailside mowing were to increase. Several plants at the Mount Tolmie subpopulation site on the University of Victoria campus appear to have been eliminated by trail widening. Only one plant now remains at one of the Cedar Hill subpopulation sites, where at least three trailside plants have been eliminated by either trampling or trail widening. Foot and dog traffic is heavy at Uplands Park (Collier *et al*. 2004). Here, winter rains result in large pools forming in the middle of trails, sometimes forcing pedestrians onto the trail margins where Foothill Sedge occurs. One of three plants at the Queenswood subpopulation was eliminated by the development of a formal trail through the site.

Unauthorized bicycle riding is a threat at Uplands Park. Bicycle traffic disturbs soil and particularly threatens trailside plants. Bike riders at this site also occasionally dig and move soil and vegetation to construct jumps or obstacles.

At Harewood Plains, recreational all-terrain vehicle traffic has created deep and lasting ruts through vernal pools, swales, and meadows and has also resulted in extensive erosion of the thin topsoil in sloping upland areas. In addition to altering the local hydrologic regime, off-roading has disturbed and compacted the soil, facilitated the spread of non-native species, and directly endangered the survival of at least one nationally Endangered plant, Bog Birds-foot Trefoil (*Lotus pinnatus*), through crushing (COSEWIC 2008).

Human Intrusion and Disturbance: Work & other activities [IUCN Threat 6.3 – Low impact]

Portions of Rocky Point, Uplands Park, Summit Park, and Mount Tolmie are subject to periodic mowing during the growing season. Mowing is done to maintain trails or areas of lawn, or to reduce fire hazard. Individuals appear to be highly tolerant of mowing, persisting for long periods under mowing regimes and regrowing leaves following loss. However, the central ammunition depot at Rocky Point, which has been mowed regularly for decades, supports a much lower concentration of Foothill Sedge than the surrounding, unmowed, meadows. This suggests that there may be a threshold beyond which mowing represents a threat. Repeated mowing during the growing season prevents Foothill Sedge from producing flowers and seeds, limiting reproduction.

Transportation and Service Corridors: Roads and Railroads [IUCN threat 4.1 – Low impact]

Portions of the subpopulations at Lochside Trail, Mount Tolmie, and Rocky Point are found along roadsides. These plants are vulnerable to roadside mowing, ditch maintenance, and potentially road resurfacing or expansion. The roadside plants at the Mount Tolmie subpopulation site could not be found in 2020 and appear to have been eliminated. The exact cause could not be ascertained.

The Cuthbert Holmes subpopulation was discovered in 2015 during surveys that were conducted in preparation for the development of the McKenzie Interchange, a major development of a highway intersection. Three of the four plants found were subsequently destroyed by the project.

Limiting Factors

Foothill Sedge is a slow-growing species with apparently long generation times. Given the very small effective sizes of most subpopulations, loss of vigour due to local inbreeding effects could be a limiting factor for this species in Canada. The species appears to be limited by low rates of seedling establishment.

Number of Locations

The most significant threats to Foothill Sedge are non-native plants and encroachment by native trees and shrubs. However, these threats do not result in a single damaging event that rapidly affects multiple occurrences, because the effect and magnitude of the threats vary according to the management of each individual site. As a result, each subpopulation represents one or more locations. The total number of locations in Canada is at least 23.

PROTECTION, STATUS, AND RANKS

Legal Protection and Status

Foothill Sedge is not covered under CITES (Convention on International Trade in Endangered Species) or the *Endangered Species Act* (USA). Foothill Sedge is listed as Endangered in Schedule 1 of Canada's *Species at Risk Act*. The act prohibits harm to this species on Federal Lands, in this case Department of National Defence and Parks Canada lands. The Sidney Island north subpopulation occurs within Gulf Islands National Park Reserve, where harm to natural features, including Foothill Sedge, is prohibited by the park regulations. Likewise, several subpopulations of Foothill Sedge are located in municipal and regional parks, where parks and protected areas bylaws prohibit harm to natural features, including Foothill Sedge.

A portion of the Braefoot subpopulation is protected within a conservation covenant.

A Recovery Strategy for the Foothill Sedge was prepared in 2013 (Parks Canada Agency 2013). Recovery actions identified in the Strategy have been implemented at some sites, including habitat and species protection, stewardship, and monitoring (see **Habitat Protection and Ownership** section).

Non-Legal Status and Ranks

The Foothill Sedge has not been assessed by the International Union for the Conservation of Nature (IUCN 2021). Globally, it is ranked Apparently Secure (G4), although the status has not been reviewed since 1985 (NatureServe 2020). It is not ranked in Washington, Oregon, or California but is ranked SH (possibly extirpated) in Idaho. The species is currently ranked Vulnerable to Apparently Secure (S3S4) in BC (BC Conservation Data Centre 2020b).

Habitat Protection and Ownership

Ownership of the site of each subpopulation is shown in Table 1. Of the 23 known subpopulations, 8 occur within municipal parks, 5 are on private lands, and 4 are on lands under the administration of Canadian Forces Base Esquimalt, Department of National Defence. The remaining 6 subpopulations include one each of the following land tenures: Parks Canada, University of Victoria, regional park, split ownership Department of National

Defence / Indian Reserve, split ownership University of Victoria / municipal park, and split ownership municipal right-of-way / private land.

At all subpopulations on Department of National Defence lands, Foothill Sedge and other species at risk are regularly surveyed and monitored. The habitat surrounding occurrences of Foothill Sedge is protected from damage or disturbance within a 20-m radius of all plants. Continued use of roads or other existing infrastructure within 20 m of plants is permitted. At the Rocky Point, Naden, and Albert Head subpopulation sites, ecosystem-based management activities control non-native species and ingrowth of native woody vegetation. Funding for protection and management actions on DND lands is prioritized for species listed under the *Species at Risk Act*. Species not protected by the Act do not receive the same level of protection.

At the Sidney Island north subpopulation site, Parks Canada controls the growth of non-native woody vegetation within 10 m of all Foothill Sedge plants (Lawn pers. comm. 2020). Funding for this activity is provided based on the species being protected under the *Species at Risk Act*.

Natural habitat in several municipal parks (e.g., Uplands Park, Victoria) where Foothill Sedge occurs is subject to restoration programs to protect species at risk and other native flora. Non-native woody vegetation is removed at the Swan Lake Nature Sanctuary, Cedar Hill Park, and Mount Tolmie. These habitat-oriented projects do not specifically target Foothill Sedge. At Playfair Park, a dedicated restoration project targeted non-native grasses and forbs and resulted in dramatic recovery of the native herbaceous community. This has led to recovery of suppressed, naturally occurring individuals of Foothill Sedge and has also included outplanting of container-grown individuals. In Saanich Parks, these volunteer activities are supported by the District of Saanich through the Pulling Together program (District of Saanich 2020).

The University of Victoria currently has an active restoration and nature group that is attempting to reduce non-native species and protect natural features. This group is working towards ecological restoration of a remnant meadow and oak woodland community that formerly supported Foothill Sedge (Pimm pers. comm. 2020). Actions to date include removal of non-native plants and encroaching native shrubs, installation of native plants, and addition of native seed. The group is aware of Foothill Sedge and has collected seed from the extant portion of the subpopulation.

On private lands in Saanich, Foothill Sedge has been given consideration during development applications. This process resulted in a portion of the Braefoot subpopulation being protected within a conservation covenant.

The recovery strategy for Foothill Sedge identifies critical habitat at several subpopulation sites. Parks Canada has legally protected critical habitat in Gulf Islands National Park Reserve.[1]

[1] See the legal protection statement, dated 19 Dec 2014, at: https://species-registry.canada.ca/index-en.html#/documents/2572

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BIOGRAPHICAL SUMMARY OF REPORT WRITER(S)

James Miskelly completed an M.Sc. in Biology at the University of Victoria in 2004. Since then, he has been involved with a variety of projects related to species at risk and restoration of Garry Oak ecosystems. He currently works with Natural Resources Canada's Federal Lands Program in Victoria, BC, working primarily on the lands administered by Canadian Forces Base Esquimalt.

Andrea Schiller has a B.Sc. in Biology and Environmental Studies from the University of Victoria (2001). Since 2006, she has worked with Natural Resources Canada's Federal Lands Program, with a focus on conservation of rare species, ecological restoration, and GIS.

COLLECTIONS EXAMINED

No collections or specimens were examined in person during the preparation of this report. However, photos of putative specimens of Foothill Sedge were viewed from the University of Washington Herbaria (accessed through the Consortium of Pacific Northwest Herbaria website, specimen accession numbers WTU-407253 and WTU-407254) and Humboldt State University Herbarium (photo requested by email, specimen accession number HSC-48189).

Appendix 1. IUCN Threats assessment of Foothill Sedge

THREATS ASSESSMENT WORKSHEET				
Species or Ecosystem Scientific Name	Foothill Sedge (*Carex tumulicola*)			
Element ID		**Elcode**		
Date (Ctrl + ";" for today's date):	08/06/2021			
Assessor(s):	Del Meidinger (SSC Co-chair, facilitator), Bruce Bennett (SSC Co-chair), Andrea Schiller (report writer), James Miskelly (report writer), Jenifer Penny (BC and SSC), Rebekah Neufeld (SSC), Cary Hamel (SSC), Dan Brunton (SSC), Varina Crisfield (SSC), David Mazzerole (SSC), Ross Vennesland (CWS), Angele Cyr (Secretariat)			
References:				
Overall Threat Impact Calculation Help:			**Level 1 Threat Impact Counts**	
	Threat Impact		**high range**	**low range**
	A	Very High	0	0
	B	High	0	0
	C	Medium	0	0
	D	Low	4	4
Calculated Overall Threat Impact:			Medium	Medium
Assigned Overall Threat Impact:			**C = Medium**	
Impact Adjustment Reasons:			Participants felt that a Medium threat impact where a decline in the population of 3%–30% over three generations based on threats over the next 10 years was very reasonable. However, following the call, a couple of participants felt that Medium–Low might better reflect the true situation.	
Overall Threat Comments			Generation time: 10 years.	

Threat		**Impact (Calculated)**		**Scope (Next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development		Negligible	Negligible (<1%)	Extreme (71%–100%)	High (Continuing)	
1.1	Housing & urban areas		Negligible	Negligible (<1%)	Extreme (71%–100%)	High–Moderate	Five subpopulations on private lands; one subpopulation partly on private land. Portion of Braefoot subpopulation is in conservation covenant. Harewood Plains area proposed for development in the past and could be so again. UVIC and Mt. Tolmie sites at risk of development at university.
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas		Negligible	Negligible (<1%)	Extreme (71%–100%)	High (Continuing)	Trail widening or trail development at nine sites in parks. Example at Queenswood where plant lost.
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						

Threat		Impact (Calculated)		Scope (Next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.4	Marine & freshwater aquaculture						
3	Energy production & mining						
3.1	Oil & gas drilling						
3.2	Mining & quarrying						
3.3	Renewable energy						
4	Transportation & service corridors	D	Low	Small (1%–10%)	Extreme (71%–100%)	Moderate–Low	
4.1	Roads & railroads	D	Low	Small (1%–10%)	Extreme (71%–100%)	Moderate–Low	Recent loss of plants due to road building or widening highlights risk to plants at several subpopulations.
4.2	Utility & service lines						
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use						
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance	D	Low	Small (1%–10%)	Serious–Slight (1%–70%)	High (Continuing)	
6.1	Recreational activities	D	Low	Small (1%–10%)	Moderate–Slight (1%–30%)	High (Continuing)	Plant occurs along walking paths at nine parks. Trampling and unauthorized cycling could impact plants. Trampling may also keep trailside habitat from encroachment by shrubs. At Harewood Plains, ATV use is a potential issue, although less ATV use noted recently than up to 2011–2012.
6.2	War, civil unrest & military exercises						

Threat		Impact (Calculated)		Scope (Next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.3	Work & other activities	D	Low	Small (1%–10%)	Serious–Slight (1%–70%)	High (Continuing)	Trailside or roadside mowing at some sites could impact plants. Periodic mowing at four sites occurs during growing season. Although Foothill Sedge appears to be tolerant of mowing, it could impact density of plants, as evident at Rocky Point, where mowing has occurred regularly. Parts of Rocky Point are mowed regularly to reduce fire hazard in areas used for explosives storage and disposal. These plants are mowed often enough that some appear damaged and none produce seeds. Under the current mowing regime, some plants will die over the next three generations. What proportion is uncertain but it could be serious in these areas. Uprooting invasive plants, by well-meaning but inexperienced people, could inadvertently kill or disturb sedge plants. Roadside mowing can benefit sedge by keeping invasive shrubs down.
7	Natural system modifications	D	Low	Pervasive (71%–100%)	Slight (1%–10%)	High (Continuing)	
7.1	Fire & fire suppression		Negligible	Pervasive (71%–100%)	Negligible (<1%)	High (Continuing)	Suppression of natural and First Nations fires has allowed for encroachment of trees and woody shrubs, increasing density of stands. Douglas-fir, native rose. Species is fire resistant.
7.2	Dams & water management/use						
7.3	Other ecosystem modifications	D	Low	Pervasive (71%–100%)	Slight (1%–10%)	High (Continuing)	Garry Oak and associated ecosystems have been invaded by non-native plants such that exotic species now comprise 59%–82% of the total herbaceous cover. The rate of invasion is accelerating. Invasive grasses dominate the cover at all sites and although the impact is not clear, they may be limiting recruitment of Foothill Sedge through competition. Lack of recruitment appears related to invasive species invasion. Severity at low end of slight category.
8	Invasive & other problematic species & genes	D	Low	Large (31%–70%)	Slight (1%–10%)	High (Continuing)	

Threat		Impact (Calculated)		Scope (Next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.1	Invasive non-native/alien species/diseases	D	Low	Large (31%–70%)	Slight (1%–10%)	High (Continuing)	Invasive shrubs and trees have the potential to transform the sites, e.g., meadows to shrub thickets. Modification of sites by shrub and tree in-growth, due to fire suppression, and invasion of sites by exotic trees and shrubs. In this case, it is overtopping of sedges, mostly by woody vegetation, that reduces its vigour and kills plants, depending upon the density of the canopy and the characteristics of the woody species. Estimate that about 50% of plants are shaded or are likely to be shaded over the next 10 years. Suppressed individuals are sometimes found under invasives that respond after invasive species removal, but other invasives, like Gorse, kill species. Management occurs at some sites but is “unstable,” i.e., it is based on volunteer participation and is based on SARA listing of species.
8.2	Problematic native species/diseases						
8.3	Introduced genetic material						
8.4	Problematic species / diseases of unknown origin						
8.5	Viral/prion-induced diseases						
8.6	Diseases of unknown cause						
9	Pollution						
9.1	Domestic & urban waste water						
9.2	Industrial & military effluents						
9.3	Agricultural & forestry effluents						
9.4	Garbage & solid waste						
9.5	Airborne pollutants						
9.6	Excess energy						
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather		Unknown	Pervasive–Large (31%–100%)	Unknown	High (Continuing)	

Threat		Impact (Calculated)		Scope (Next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.1	Habitat shifting & alteration		Unknown	Pervasive–Large (31%–100%)	Unknown	High (Continuing)	Climate change will cause shifts in vegetation communities in future although the impact on Foothill Sedge is unknown at this time. Recent summers of drought are showing an impact on some tree and shrubs, e.g., shrub thickets dying back. It is possible that climate-related habitat shifting may increase habitat for the sedge, but it may also impact existing sites of sedge due to increasing drought. The global range of the species indicates it can survive in drought conditions, but it is unknown if the local genotype is adapted to drought. Species moving to ecologically suitable sites is limited by high cover of invasive species and this is likely to continue to be an issue.
11.2	Droughts						Drought discussed as part of 11.1.
11.3	Temperature extremes						
11.4	Storms & flooding		Negligible	Negligible (<1%)	Slight (1%–10%)	High (Continuing)	Several subpopulations occur on slumping banks along shorelines; sea level rise and storms will cause continuing erosion and potential loss of plants.
11.5	Other impacts						

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