COSEWIC
Assessment and Status Report

on the

Lakeside Daisy
Tetraneuris herbacea

in Canada

SPECIAL CONCERN
2021

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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Previous report(s):

COSEWIC 2002. COSEWIC assessment and status report the lakeside daisy *Hymenoxys herbacea* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 24 pp.

Campbell, L.B. Husband and M.J. Oldham 2002. COSEWIC status report on the lakeside daisy *Hymenoxys herbacea* in Canada, *in* COSEWIC assessment and status report the lakeside daisy *Hymenoxys herbacea* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-24 pp.

Production note:
COSEWIC would like to acknowledge Judith Jones for writing the status report on Lakeside Daisy (*Tetraneuris herbacea*), in Canada, prepared under contract with Environment and Climate Change Canada. This report was overseen and edited by Del Meidinger, Co-chair of the COSEWIC Vascular Plants Specialist Subcommittee.

For additional copies contact:

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

Tel.: 819-938-4125
Fax: 819-938-3984
E-mail: ec.cosepac-cosewic.ec@canada.ca
www.cosewic.ca

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Lakeside Daisy — Photo provided by author.

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COSEWIC
Assessment Summary

Assessment Summary – April 2021

Common name
Lakeside Daisy

Scientific name
Tetraneuris herbacea

Status
Special Concern

Reason for designation
This perennial herb occurs only in the Great Lakes region where it is restricted to rare alvar and lakeshore calcareous bedrock habitats. Ninety-five percent of the world population is in Canada. This species may be very abundant where it occurs, and a few large subpopulations on western Manitoulin Island buffer the level of risk to the rest of the population. Ongoing threats include fire suppression, trampling by pedestrians, off-road vehicle use, building and road construction, quarrying, logging in adjacent forests, and invasion by exotic species. The change in status since the last assessment is the result of increased search effort and a change in interpretation of severe fragmentation.

Occurrence
Ontario

Status history
Designated Threatened in May 2002. Status re-examined and designated Special Concern in May 2021.

COSEWIC
Executive Summary

Lakeside Daisy
Tetraneuris herbacea

Wildlife Species Description and Significance

Lakeside Daisy (*Tetraneuris herbacea*) is a rhizomatous, colonial perennial in the Aster Family. In early spring it produces single, yellow, daisy-shaped heads of flowers, each borne on a hairy stalk. It is a globally significant Great Lakes endemic with a narrowly confined distribution.

Distribution

Lakeside Daisy is known only from the Great Lakes Region in Michigan, Ohio, Illinois, and Ontario. In Canada, the species occurs only in the Manitoulin Island region and on the Bruce Peninsula in Ontario. There are 25 subpopulations in the Manitoulin Island region and nine on the Bruce Peninsula for a total of 34 subpopulations in Canada. The areal size of subpopulations ranges from <100 m2 to stretches of shoreline almost 3 km long and up to 1 km wide. The Canadian range of Lakeside Daisy probably accounts for over 95% of the global population. The Canadian population is considered one designatable unit.

Habitat

Lakeside Daisy has a very narrow habitat preference and is restricted to alvar ecosystems and limestone bedrock shorelines where bedrock is exposed. Three subpopulations on the Bruce Peninsula grow on limestone boulders. Much of the habitat of Lakeside Daisy has a history of fire, but no site has had more than one fire in over 100 years, so fire may be necessary only over very long time frames.

Biology

Lakeside Daisy flowers must have pollen from a genetically different mate to set seed. Individual plants may live for several decades. The average age of individuals has been calculated to be approximately 16 years. Fruits have no special adaptations for dispersal and most seedlings appear within 1 m of adults. The Canadian population is not severely fragmented.

Population Sizes and Trends

There may be between 87,000 and 220,000 mature individuals (genets) in Canada, each with 20 to 50 ramets (clonal shoots). Available trend data for 12 subpopulations show four with decreases, six that are stable, and two that are stable or may have increased. Subpopulations can remain fairly stable for decades. No subpopulations are known to have become extirpated. Rescue from outside populations, which are much smaller or hundreds of kilometres away, is considered highly improbable.

Threats and Limiting Factors

The main threats to Lakeside Daisy are trampling by pedestrians, off-road vehicle use, building and road construction, quarrying, logging in adjacent forests and habitat infestation by exotic species. Artificially prolonged vegetation succession due to fire suppression and impacts from climate change may be affecting habitat over very long time frames. Changes in lake levels may be a limiting factor for shoreline subpopulations. There are 29 locations in Canada.

Protection, Status and Ranks

Lakeside Daisy is listed as Threatened in the federal *Species at Risk Act* (SARA) and in Ontario on the Species at Risk in Ontario (SARO) List under the *Endangered Species Act, 2007*. In the United States, it is federally listed as Threatened. It is globally ranked G3 or vulnerable, nationally N3 or vulnerable in Canada, and S3 or vulnerable in Ontario. It is ranked N1 or nationally critically imperilled in the US, and S1 or critically imperilled in Illinois, Michigan, and Ohio. Critical habitat was identified in Canada in 2011 under the SARA for 38% of Lakeside Daisy habitat area in the Manitoulin Island region and 67% on the Bruce Peninsula. Approximately 353 ha of Lakeside Daisy habitat is in protected areas, as well as 247 ha in private ownership, 71 ha in corporate ownership, and ~5 ha divided among First Nation, Crown, and municipal management.

TECHNICAL SUMMARY

Tetraneuris herbacea

Lakeside Daisy

Hyménoxys herbacé

Range of occurrence in Canada: Ontario

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 (2019) is being used)	2-3 years to reach sexual maturity; generation time calculated as 11 to 21 years with average of 16 years.
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Inferred continuing minor decline *Declines inferred from historically larger extent of habitat and from observed reduction in some habitat polygons over a 20-year time frame.*
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown; Inferred stable or very small decline
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Inferred ~stable or very slight decline *Smaller subpopulations on Bruce Peninsula are suspected to have declined; percentage unknown.*
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown; small reduction as some smaller woodland habitats start to close in at increased rate
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown; Inferred gradual ongoing declines since historical time periods and expected to continue into the future, with greater loss after three generations (48 years) in 50 – 100 years as habitats become wooded and grow in faster.
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. likely yes b. yes c. no
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	2,610 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	256 km²
Is the population “severely fragmented” i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No

Number of "locations"* (use plausible range to reflect uncertainty if appropriate)	29 locations: 27 locations with 1 subpopulation; 1 location with 4 subpopulations; 1 location with 3 subpopulations.
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?	No *Decreased number of subpopulations since the last assessment is due to new information and not an actual change.*
Is there an [observed, inferred, or projected] decline in number of "locations"*?	No
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes—observed & projected *Projected decline in area and quality due to various threats*
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**
Total: Canadian Population 34 subpopulations	Approximately 87,000 to 220,000 individuals (genets) *--Approximately 4,363,715 ramets; # ramets per individual unknown; rough assumption is that average is between 20 – 50.* *--Total abundance may be greater if presence is confirmed in unsurveyed areas*
25 subpopulations in the Manitoulin Island region	~85,584 - 214,000 individuals *approx. 4,279,215 ramets* *includes 2 historical subpopulations still considered extant* *one unsurveyed area may be an additional subpopulation.*
9 subpopulations on Bruce Peninsula	~1690 - 4225 individuals *approx. 84,500 ramets*
See Table 1 for abundance in each subpopulation	

* See Definitions and Abbreviations on the COSEWIC website and in the IUCN Guidelines (August 2019) for more information on this term

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	No PVA

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

Was a threats calculator completed for this species? Overall threats impact: Medium-Low. Low impact threats: i. Housing & urban areas ii. Mining & quarrying iii. Logging & wood harvesting iv. Recreational activities v. Fire & fire suppression vi. Invasive non-native/alien species Also one threat scored as negligible and two as unknown. What additional limiting factors are relevant?	Yes *Cyclical changes in water levels in Lake Huron – Georgian Bay change size of habitats near shoreline and affect abundance.*

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Extremely small and declining *Michigan*
Is immigration known or possible?	Highly improbable
Would immigrants be adapted to survive in Canada?	Probably
Is there sufficient habitat for immigrants in Canada?	Probably
Are conditions deteriorating in Canada?[+]	Yes; presumed very gradual deterioration
Are conditions for the source (i.e., outside) populations deteriorating?[+] *Ohio populations are in protected, actively managed areas.*	Michigan: yes Ohio: No
Is the Canadian population considered to be a sink?[+]	Not likely. *Bulk of global abundance is on Manitoulin Island.*
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species?	No

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

Status History

COSEWIC Status History: Designated Threatened in May 2002. Status re-examined and designated Special Concern in May 2021.

Recommended Status and Reasons for Designation:

Recommended Status: Special Concern	**Alpha-numeric codes:** Not Applicable
Reasons for designation: This perennial herb occurs only in the Great Lakes region where it is restricted to rare alvar and lakeshore calcareous bedrock habitats. Ninety-five percent of the world population is in Canada. This species may be very abundant where it occurs, and a few large subpopulations on western Manitoulin Island buffer the level of risk to the rest of the population. Ongoing threats include fire suppression, trampling by pedestrians, off-road vehicle use, building and road construction, quarrying, logging in adjacent forests, and invasion by exotic species. The change in status since the last assessment is the result of increased search effort and a change in interpretation of severe fragmentation.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Rate of reduction in number of mature individuals cannot be determined with present data but any decline would be below thresholds.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. EOO of 2,610 km^2 and IAO of 256 km^2 are below the threshold for Endangered, but 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. The population estimate of > 87,000 individuals exceeds thresholds.
Criterion D (Very Small or Restricted Population): Not applicable. Estimate of greater than 87,000 mature individuals is above thresholds for D1. D2 not met as population is not vulnerable to rapid and substantial decline.
Criterion E (Quantitative Analysis): Not applicable. Analysis not conducted.

PREFACE

In the last assessment, Lakeside Daisy was known as *Hymenoxys herbacea.* Since the previous status report, there has been new fieldwork on many subpopulations, including some studies with estimates of abundance derived from plot-based counts. As a result of more precise methods, the abundance values used as the basis of the previous status report have been found to be mostly inaccurate. The number of subpopulations has decreased since the last report, but this is not due to a decline. New fieldwork has shown that some subpopulations previously thought to be separate are actually connected, and some mapped together are actually separate. As well, a few localities in the previous report were found to be erroneous database entries. On the other hand, since the last report, four new subpopulations have been discovered. New values for extent of occurrence (EOO) and the index of area of occupancy (IAO) have been calculated as the previous calculation for EOO included populations outside Canada, and the previous areal extent was area of occupancy (AOO) rather than IAO calculated from a grid-reference system. The technical summary of the previous report listed the Canadian population of Lakeside Daisy as "fragmented", but since that time, the assessment criterion has been changed to "severely fragmented" and the application of this term is much more strictly defined (see COSEWIC 2017). Lakeside Daisy in Canada is now not considered severely fragmented. Since 2002, three new private nature reserves containing Lakeside Daisy have been protected on Manitoulin Island, and a new official plan has been developed for the Manitoulin District which restricts development and site alteration in alvars.

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 (2021)

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: *Tetraneuris herbacea* Greene

Synonyms: *Actinella scaposa* Nutt. var. *glabra* A. Gray 1867

Tetraneuris acaulis (Pursh) Greene 1896

Actinea herbacea (Greene) B.L. Robinson 1908

Actinea scaposa (Pursh) Spreng. var. *glabra* (A. Gray) Cronq. 1945

Hymenoxys acaulis (Pursh) Parker var. *glabra* (A. Gray) Parker 1950

Hymenoxys herbacea (Greene) Cusick 1991

Common Name: Lakeside Daisy, Manitoulin Gold, Stemless Rubberweed, Eastern Four-nerved Daisy

Nom commun: hyménoxys herbacé

Family: Asteraceae

Major plant group: Dicot, Angiosperm

The name Lakeside Daisy was first used to refer to plants in the Marblehead Quarry at Lakeside, Ohio (Weed 1890; Cusick 1991). The Latin name refers to four (*tetra*) nerves or veins (*neuris*) in the ray petals (Bierner and Turner 2006).

In the time since the first collection, Lakeside Daisy has been placed in four different genera (above), and some authors considered it a glabrous variety of *Hymenoxys acaulis*, a widespread western species (Oldham 1997). The boundaries of the genus *Hymenoxys* have sometimes been defined broadly to include *Tetraneuris* and several other genera (Parker 1950; Karis and Ryding 1994), or more narrowly with *Tetraneuris* and other groups defined as separate genera (Robinson 1981; Bierner and Turner 2006). Cusick (1991) created the name combination *Hymenoxys herbacea*, separating Lakeside Daisy from *H. acaulis* based on the fact that the two taxa have different chromosome numbers and ploidy levels and occur more than 900 km apart.

Bierner and Jansen (1998) examined the distinctions between *Tetraneuris* and *Hymenoxys* using site restriction variation in cpDNA and nrDNA. They found the *Tetraneuris* taxa formed a monophyletic clade supported by 40 shared characters and a bootstrap value of 100%. Their data suggest that *Tetraneuris* is more closely related to the genus *Psilostrophe* DC. than to *Hymenoxys*.

Bierner and Turner (2003, 2006) revised the taxonomy of *Tetraneuris* to contain 14 taxa (9 species plus varieties). They classified Lakeside Daisy as *Tetraneuris herbacea* noting that the distally thickened caudices[1] and tightly clustered leaves suggest it is likely a dysploid derivative (2*n* = 28) that evolved from the *Tetraneuris acaulis* complex.

Morphological Description

Lakeside Daisy (Figure 1a,b) is a low, perennial, herbaceous plant in the Aster Family. It forms rhizomatous clusters of many connected, genetically identical ramets, which consist of a rosette (a small stem and circular ring of basal leaves), with or without a scape (an upright, leafless stalk which bears the flower head). The ramets are produced from adventitious shoots from a branched caudex. The leaves are thick and leathery, and the blades are entire, narrow, oblanceolate, and 1 to 8 cm long. The leaves may be densely hairy when young but become hairless and dotted with tiny glands when fully grown. Some leaves generally persist through the winter and are green in early spring. Single daisy-like heads of yellow flowers are borne on leafless scapes 6 to 35 cm tall. The scapes are hairy towards the top. The heads are radiate[2], with 14 to 27 pistillate ray florets 0.5 to 2 cm long, each with four nerves. The centre of the head is 0.8 to 2 cm in diameter and made up of 50-100 bisexual disc florets 3 to 4 mm in diameter. The cypsela, a dry fruit, is 2 to 3 mm long, with a pappus of 4 to 7 unbarbed scales (Gleason and Cronquist 1994; Bierner and Turner 2006).

[1] Caudex: a perennial woody stem; plural, caudices.
[2] Radiate: having petal-shaped "ray" florets around the outside of the head.

a.

b.

Figure 1. a. Lakeside Daisy showing colonies of connected ramets. b. Closer view of flower heads and ramets. Photos: Judith Jones.

Lakeside Daisy may be confused with Lance-leaved Tickseed (*Coreopsis lanceolata*), which can grow in the same habitat and which may be in bloom at the same time near the end of the bloom period of Lakeside Daisy (Jones pers. obs.). Lakeside Daisy may be distinguished from Lance-leaved Tickseed as follows:

LAKESIDE DAISY	**LANCE-LEAVED TICKSEED**
Scape hairy	Scape usually glabrous (except in uncommon hairy form)
Fruits with four scales at top	Fruits with wings and two teeth at top
Receptacle with no scales between flowers	Receptacle with chaffy scales
Ray petals pure yellow	Ray petals orange-yellow
Disc florets many, of same colour as rays	Disc florets fewer, darker than rays
Bloom period May-early June	Bloom period June-July
Restricted to alvars	Grows in several types of open habitats

Population Spatial Structure and Variability

The bulk of the population is in a few large subpopulations on western Manitoulin Island. The great abundance and areal extent of these few subpopulations may obscure the level of risk to the rest of the population.

Designatable Units

The total Canadian population is considered one designatable unit (DU). Subpopulations on the Bruce Peninsula are geographically separated from those on Manitoulin Island by almost 100 km, which is believed to be beyond the dispersal capability of this species, especially when most of that distance is water of Lake Huron. It is possible that subpopulations in the two regions have been separated long enough for local adaptation to occur. In terms of significance, the loss of the Bruce Peninsula subpopulations would cause a major reduction in the global geographic range of the species and in the Canadian extent of occurrence (EOO) and index of area of occupancy (IAO). However, no genetic work has been done on local adaptations, and no obvious phenotypical differences have been observed. Therefore, the total Canadian population within both regions is considered one designatable unit.

Special Significance

The species is significant as a component of the endemic Great Lakes flora (Morton and Venn 2000). It is one of the few plant species with most (95%) of its global population in Canada. The species occurs predominantly in alvars, a globally rare community type (Brownell and Riley 2000), where it frequently associates with other globally and provincially rare species. In areas where it is abundant, its pollen likely supports a large group of insect visitors in the early spring when other food sources are limited (Campbell 2001). It is also a showy species that has been recognized for its beauty on a Canadian postage stamp. The plant is considered a choice rock garden plant and is available commercially from specialty nurseries under a wide variety of Latin and English names. It is not known to have cultural value or medicinal usage.

There is no species-specific Aboriginal Technical Knowledge in this report. However, Lakeside Daisy, like all species, is important to Indigenous peoples who recognize all interrelationships within an ecosystem.

DISTRIBUTION

Global Range

Lakeside Daisy is restricted to the Great Lakes Region (Morton and Venn 2000) and known only from Ontario, Michigan, Ohio, and Illinois (NatureServe 2019, Figure 2). In Michigan in the Upper Peninsula in Mackinac County, there are three subpopulations: one is presumed natural and two are introductions. In Ohio, there are two subpopulations (U.S. Fish and Wildlife Service 2018): a natural one on the Marblehead Peninsula and an introduction on Kelleys Island (U.S. Fish and Wildlife Service 2016). In Illinois, Lakeside Daisy was present historically in remnant prairies in two counties but was extirpated in the early 1980s. It was restored to five sites in the state between 1988 and 1994 from plants preserved in a garden and from seeds from Ohio and Canadian populations. Two of the restored subpopulations and two additional introduced subpopulations survive in Illinois but all have fewer than 200 plants (Illinois Natural Heritage Database 2019) and none are considered viable populations (U.S. Fish and Wildlife Service 2016). In Ontario, the species occurs in the Manitoulin Island region and on the Bruce Peninsula. The bulk of the global population of this species, in terms of occupied area and numbers of individuals, is on Manitoulin Island.

Cusick (1991) suggested that the ancestors of Lakeside Daisy probably migrated from the western cordillera to the Great Lakes region about 8000 years ago across the "prairie peninsula", when warm, dry conditions stretched across the continent (Transeau 1935). DeMauro (1990) speculated that as climate became moister, the species became restricted to suitable dry habitats. Bierner and Turner (2003) suggested that Lakeside Daisy may have arisen from divergent populations of Stemmy Four-nerve Daisy (*T. scaposa* var. *scaposa*) along the receding ice front during the last glaciation.

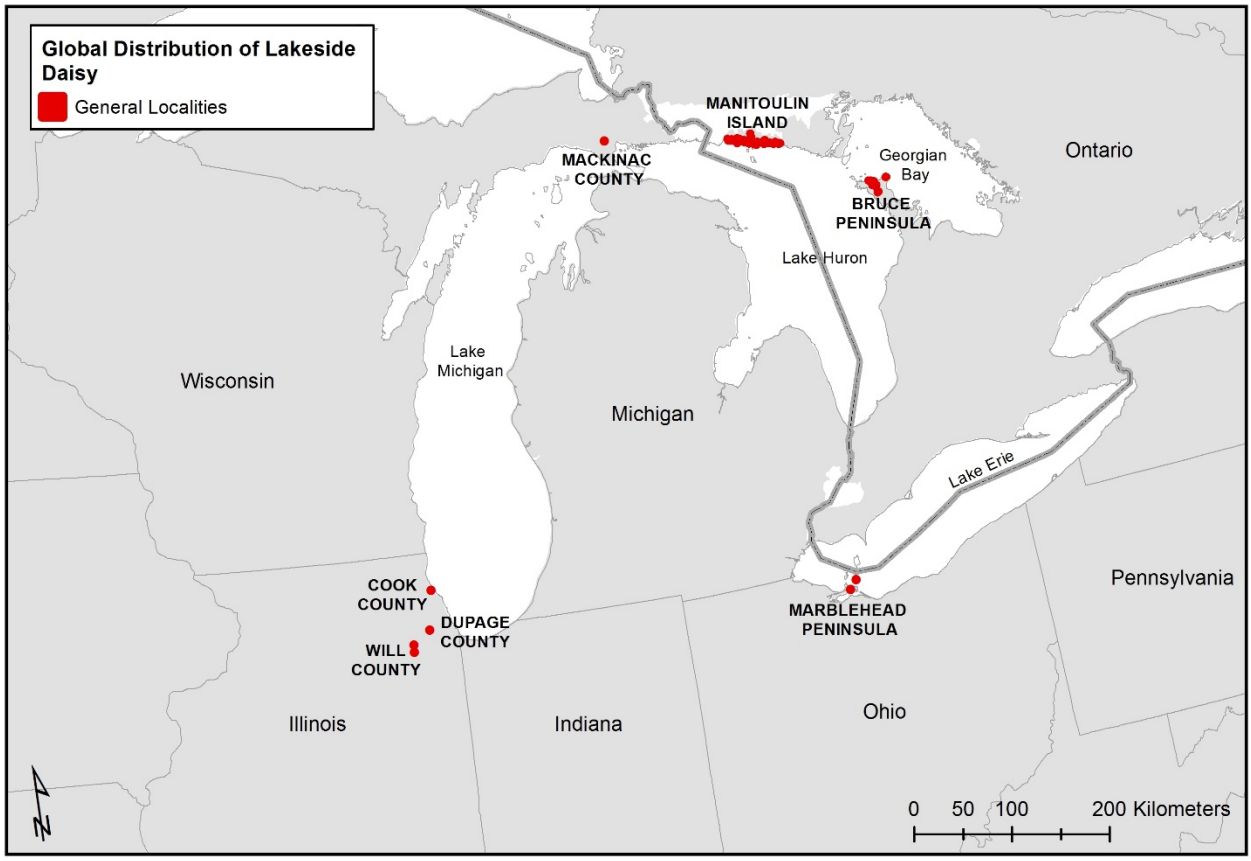

Figure 2. Global distribution of Lakeside Daisy. Sources for U.S. populations: U.S. Fish and Wildlife Service (2016); Illinois Natural Heritage Database (2019).

Canadian Range

In Canada, Lakeside Daisy is only found in Ontario: on the northern Bruce Peninsula, on the south shore of Manitoulin Island, and on Greene Island in Lake Huron just south of Manitoulin Island (Figure 3a,b). There are 25 subpopulations in the Manitoulin Island region (including Greene Island) and 9 subpopulations on the Bruce Peninsula, for a total of 34 subpopulations in Canada (Table 1). There is also an introduced population in an abandoned quarry just north of the City of Hamilton (Curry 2015), which is not included in the calculations in this report. In the Manitoulin Island region, 2 of the 25 are considered historical because they have not been reconfirmed in more than 40 years, but both are presumed extant because suitable alvar habitat is visible on satellite imagery and neither area is easily accessible. One additional area, which is remote and on private property, has not been surveyed but presence is highly likely judging from observations of suitable habitat on satellite imagery and documented presence in the next-nearest alvars. This area may be one additional subpopulation (not yet included in analyses). The areal size of Lakeside Daisy subpopulations ranges from <100 square metres to two stretches of Manitoulin Island shoreline, each almost 3 km long and up to 1 km wide. The Canadian range of Lakeside Daisy probably accounts for 95% or more of the global population (Parks Canada Agency 2011).

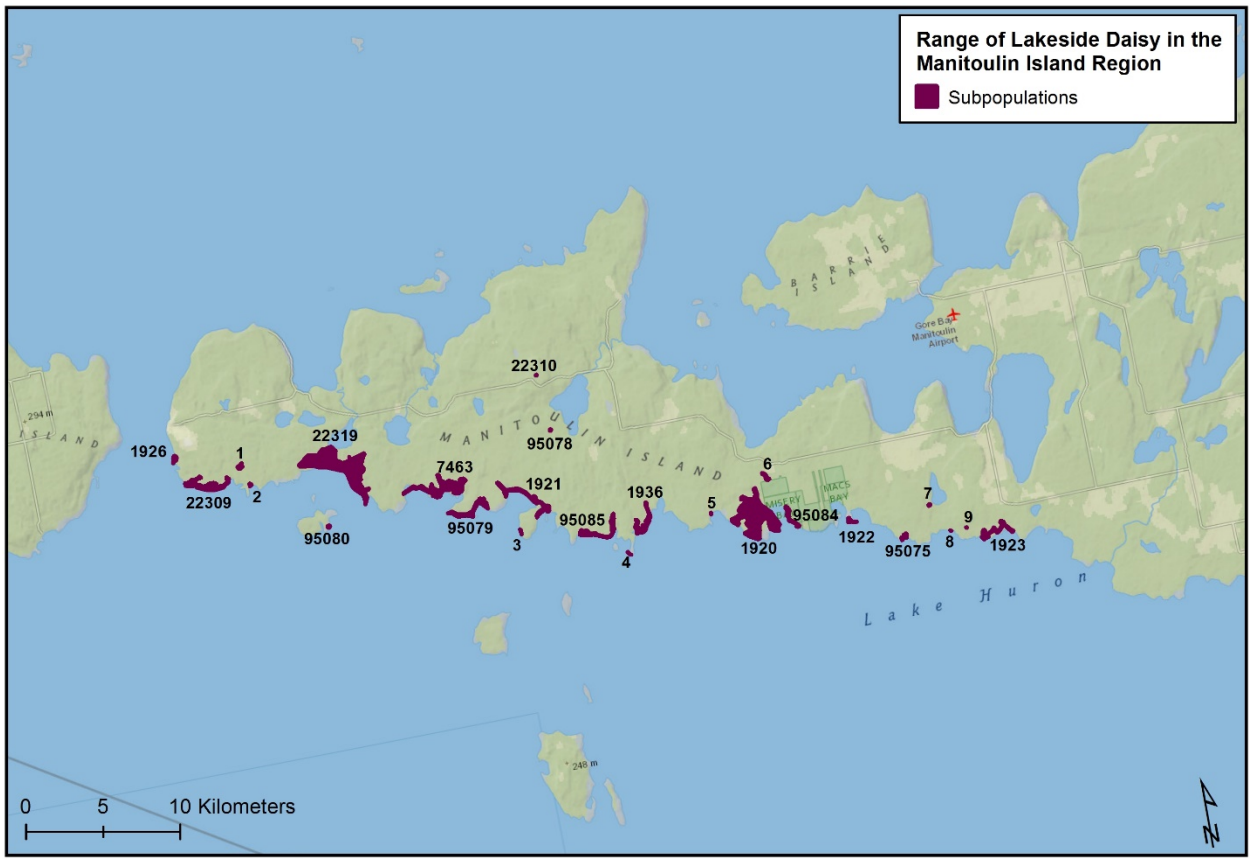

Figure 3a. Range of Lakeside Daisy in the Manitoulin Island region. Purple shading indicates generalized subpopulation area in which Lakeside Daisy polygons occur (but species may not occupy all of shaded area). Subpopulation element occurrence numbers refer to information in Table 1.

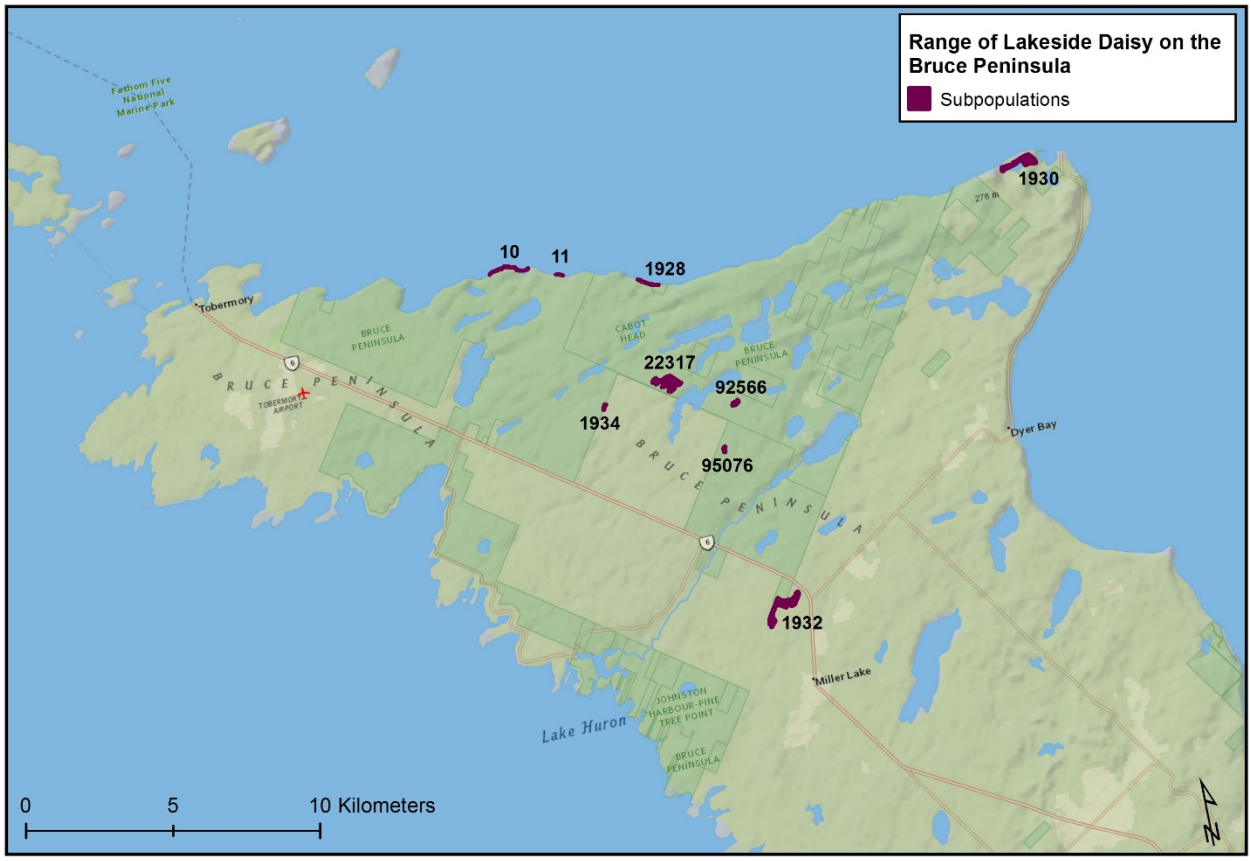

Figure 3b. Range of Lakeside Daisy on the Bruce Peninsula. Purple shading indicates generalized subpopulation area in which Lakeside Daisy polygons occur (but species may not occupy all of shaded area). Subpopulation element occurrence numbers refer to information in Table 1.

Table 1. List of Lakeside Daisy subpopulations with dates of most recent abundance observation, observer name, approximate abundance (numbers of ramets), and habitat area. (Sources: Campbell 2001; McGuire 2006; Jones 2015; Wallace *et al.* 2016; NHIC 2018; Miller pers. comm. 2019). Subpopulations with # symbols in the left-hand column do not have an assigned element occurrence number.

Element Occurrence # / # in COSEWIC (2002)	Subpopulation Name (listed alphabetically in each region)	Date and observer of most recent abundance estimate	Approximate abundance (ramets)	Total habitat area (ha)
Manitoulin Island Region				
7463 / 35	Belanger Bay West & East	2016 Wallace *et al.*	~200,000	90.7
1921 / 34	Burnt Island Harbour - Christina Bay	2016 Wallace *et al.*	433,000?	22.5
#3	Burnt Island Shoreline	2016 Wallace *et al.*	2,900	0.6
1936 / 27 - 30	Carroll Wood Bay	2004 Jones	high 10,000s	26.3
95085	East of Black Point - Fisher Bay	2006 Jones	10,000s	31.2
95079	Girouard Pt. - Rickley Harbour	2016 Wallace *et al.*	135,000	23.9

Element Occurrence # / # in COSEWIC (2002)	Subpopulation Name (listed alphabetically in each region)	Date and observer of most recent abundance estimate	Approximate abundance (ramets)	Total habitat area (ha)
95080	Greene Island	2005 Jones	10,000s	1.5
#7	Lorne Lake	1996 Jones	100s	1.0
#2 / 37	Lynn Bay	2005 Jones	5000-10,000	1.3
#1	Lynn Point North	2007 Bakowsky *et al.*	no data	3.7
95084 / 22	Misery Bay East	2016 Wallace *et al.*	~4000	7.7
#6	Misery Bay North	1976 Winterhalder	no data	3.8
1920 / 21, 23, 24, 25	Misery Bay West Includes area erroneously called Sand Bay in COSEWIC (2002)	2016 Wallace *et al.*	1,148,084	218.8
1926 / 39	Mississagi Lighthouse	2016 Wallace *et al.*	2000	4.3
1922 / 20	Murphy Point	2016 Wallace *et al.*	13,390	5.1
22319 / 36	Quarry Bay Includes Quarry Point and Quarry Bay Nature Reserve (EO#1927)	2016 Wallace *et al.*	>80,000	82.4
22310 / 32	Silver Water Radio Towers	2016 Wallace *et al.*	458	0.2
95078 / 33	SW of Silver Lake	2016 Wallace *et al.*	7,083	0.5
#8	Taskerville Centre	2015 Jones	<1000	0.1
1923 / 17,18, 19	Taskerville East - Bay West of Portage Bay Includes erroneous reports called Portage Bay and Shrigley Bay	2015 Jones	865,000	15.6
#9	Taskerville Northeast	2015 Jones	100s	0.1
95075	Taskerville West	2015 Jones	1,135,000	3.1
#3 / 31	Walkhouse Point	1961 Budd	no data	no data
22309 / 38	West of Lynn Point	2016 Wallace *et al.*	~100,000	63.2
#5 / 26	West of Sand Bay	2016 Wallace *et al.*	4000-5000	0.2
	Manitoulin Island region totals		**~4,279,215**	**607.8**
Bruce Peninsula				
1930 / 4	Cabot Head	2006 McGuire	~10,000	9.8
1932 / 10, 12, 14	Dyer's Bay Road - Bruce Alvar Nature Reserve	2006 McGuire 2006 Haselmeyer *et al.*	~10,000	13.1
1934 / 2, 3	Emmett Lake Rd – Saugeen Hunting Grounds	2006 McGuire	3200	0.5
22317 / 16	George Lake Alvar	2017 Miller	2000	18.0
92566	George Lake South	2006 Jalava	11,000	1.6
#10 / 1, 7, 9, 11, 13	The Grotto - Overhanging Point	2006 McGuire	31,000	1.3
1928 / 5, 6, 15	Halfway Log Dump - Cave Point Includes erroneous reports called Emmett Lake Trail	2006 McGuire	4300	0.8

Element Occurrence # / # in COSEWIC (2002)	Subpopulation Name (listed alphabetically in each region)	Date and observer of most recent abundance estimate	Approximate abundance (ramets)	Total habitat area (ha)
95076	South East of George Lake	2009 Jalava	6000	0.9
#11 / 8	West of Cave Point - ENE of Horse Lake	2006 McGuire	~7000	0.2
	Bruce Peninsula totals		**~84,500**	**46.2**
	Canada total		**4,363,715**	**654**

The documented distribution of Lakeside Daisy has not changed since 2002. COSEWIC (2002) reported 38 extant subpopulations and one extirpated subpopulation, but there is no mention of which subpopulation was presumed extirpated, and no subpopulations are currently known to have disappeared or changed in areal extent. All subpopulations listed as extant in COSEWIC (2002) have been documented as extant in more recent visits or found to be erroneously recorded localities. Only the two historical subpopulations (1961 and 1976), and one other subpopulation on Manitoulin Island (1996) have not been visited since 2002 (Table 1). The latter is on the inaccessible private property of a conservation-minded landowner, is presumed to be still extant, and is included in the tally of 34 extant subpopulations.

The Recovery Strategy for Lakeside Daisy in Canada (Parks Canada Agency 2011) lists 20 subpopulations in the Manitoulin Island region and 9 on the Bruce Peninsula. The five subpopulations omitted are the two historical ones and three small, outlying patches separated from known subpopulations by at least 1 km.

Occasionally, small clusters of Lakeside Daisy get established on gravel roadsides. The plants usually persist for a few years and then get destroyed by vehicles or road work. As these clusters are not in intact habitat and usually do not persist, they are not considered viable subpopulations. Lakeside Daisy has been reported at least four times from Manitoulin Island roadsides, but none of these occurrences have persisted. No roadside patch is known to have increased in size or established new seedlings. A tiny roadside occurrence of approximately 40 ramets has persisted on the Bruce Peninsula for five years to date (Miller pers. comm. 2019) but at this time is not considered a viable subpopulation as it is likely only one or very few genetic individuals.

For this report, new analysis was done to delineate subpopulations based on a separation of 1 km of persistently unsuitable habitat (no Lakeside Daisy present for at least 1 km between the edge of one patch and the nearest edge of any other patch; and the intervening land covered with permanently unsuitable habitat, such as non-alvar forest). This methodology follows guidance for defining vascular plant occurrences (NatureServe 2004). In cases where less than 1 km of unsuitable habitat intervened, patches were considered to belong to a single subpopulation although the actual potential for dispersal or exchange of propagules across several hundred metres of forest is unknown. There were no cases where more than 1 km of apparently suitable, unoccupied habitat separated Lakeside Daisy patches, so a larger separation distance was not considered.

As a result of this methodology, and as a result of new fieldwork showing some additional occupancy between known patches, several localities previously listed as separate subpopulations have now been combined reducing the number of subpopulations. In addition, field investigations have shown that some previously reported localities were erroneous database entries. On the other hand, the delineation also resulted in separating a few former single subpopulations into more than one. The overall net result is a smaller number of subpopulations than in 2002, but this does not constitute a decline.

DeMauro (1990) speculated Lakeside Daisy might not be native to the Bruce Peninsula because the species was not reported in 1933-1936 botanical surveys by Krotkov. However, in his monograph, Krotkov (1940) makes no mention of limestone pavements in sections titled "Topography" and "Minor Formations", and other obvious alvar-restricted species are also missing from his species lists. At the time of his surveys, there were very few roads on the northern Bruce Peninsula, and the road that currently goes near Emmett Lake and George Lake did not exist. An examination of Krotkov's hand-drawn mapping used to prepare the monograph (Krotkov unpubl. 1939) shows that he did not visit any of the areas near current Lakeside Daisy subpopulations.

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO) of Lakeside Daisy in Canada is 2,610 km², of which 78% or 1,967 km^2 is water of Lake Huron and Georgian Bay. The index of area of occupancy (IAO) in Canada in 2 x 2 km squares is 256 km^2, of which 204 km^2 are in the Manitoulin Island region and 52 km^2 are on the Bruce Peninsula.

The 75,246 km^2 EOO value reported in COSEWIC (2002) is vastly greater than the current calculation, but the distribution of the species has not changed since 2002. The previous value probably included the Michigan and Ohio populations. Therefore, EOO in 2002 and 2019 cannot be compared. Similarly, the previous value reported for areal occupancy of 14 km^2 is much smaller than current calculations for IAO, but again the distribution has not changed. The previous value was likely based on occupied habitat or area of occupancy (AOO).

Parks Canada Agency (2011) reports a value of 2,340 km^2 for EOO and 114 km^2 for IAO for the 29 subpopulations listed in that document. The addition of the five subpopulations that were not included would account for the smaller EOO value in 2011. Thus, the increase in EOO since 2011 is due to additional data, not to increased dispersal. The 2011 IAO value is based on 1 x 1 km grid squares (Parks Canada Agency 2011) rather than the current 2 x 2 km standard. Using a 1 x 1 km grid results in more precise mapping and less non-habitat area in each box. Thus, the increase in IAO since 2011 is due to different method and to the five omitted subpopulations and not to increased dispersal.

Search Effort

There are collections and recorded observations of Lakeside Daisy going back to at least 1950 (NHIC 2018) and informally to well before that (Jones unpublished oral history data collected 1995-1996). Most of the more than 300 records in the database of the Ontario Natural Heritage Information Centre (NHIC 2018) have only presence/absence information and a vague locality. Some of these older records were mapped approximately from known locations of subpopulations or from alvar habitats visible on satellite imagery. Almost all older records also have more recent observations with more precisely referenced locality data.

All subpopulations have been surveyed since 2002 (Table 1) except three (two historical; one visited in 1995). In addition, many large subpopulations have been partially surveyed at different dates by different people, and often the area surveyed has not been well reported. Many subpopulations are in protected areas or in remote, difficult to access locations. Therefore, if suitable habitat still exists on satellite imagery and no disturbance is known to have occurred, the species is presumed to be still present. Table 1 shows the dates of most recent abundance observation for all subpopulations. See also **Sampling Effort and Methods**.

No new fieldwork was done to support this report in light of the abundant and long-standing existing site data on most Canadian subpopulations. Since COSEWIC (2002), there have been several studies which included fieldwork on existing subpopulations (see **Sampling Effort and Methods**). Alvar habitats are highly visible on satellite imagery, and major studies (Reshcke *et al.* 1999; Brownell and Riley 2000; Jalava 2008) have been directed to surveying as much alvar as possible. Thus, it is known that all major alvar complexes in the Bruce Peninsula-Manitoulin Island region (with one exception—see **Canadian Range**) have been surveyed, and it is unlikely that a new, large subpopulation would be discovered. However, Lakeside Daisy is sometimes found in very small, remote alvar openings in a large wooded landscape. None of these numerous openings has been checked, so the discovery of additional small, isolated subpopulations is possible.

HABITAT

Habitat Requirements

Lakeside Daisy has a very narrow habitat preference, being restricted to alvars and limestone bedrock shorelines with exposed bedrock. Alvars are naturally open areas with shallow soils over relatively flat, limestone or dolostone bedrock, with trees absent or at least not forming a continuous canopy (Reschke *et al.* 1999; Brownell and Riley 2000). The dominant vascular plants are a characteristic group of native graminoids or low creeping shrubs. Alvars that are habitat for Lakeside Daisy usually have patches of mosses, lichens, and exposed bedrock (Figure 4). Due to shallow soil (0-15 cm) over impervious bedrock, alvars experience extremes of drought in summer and flooding after rain. They also experience extremes of temperature, wind, and light levels (Reschke *et al.* 1999). Alvars

contain many species that normally live in other regions such as boreal and prairie biomes (Catling 1995; Catling and Brownell 1995). All alvar vegetation types, including the habitat of Lakeside Daisy, are rare and ranked of conservation concern in Ontario (NHIC 2019).

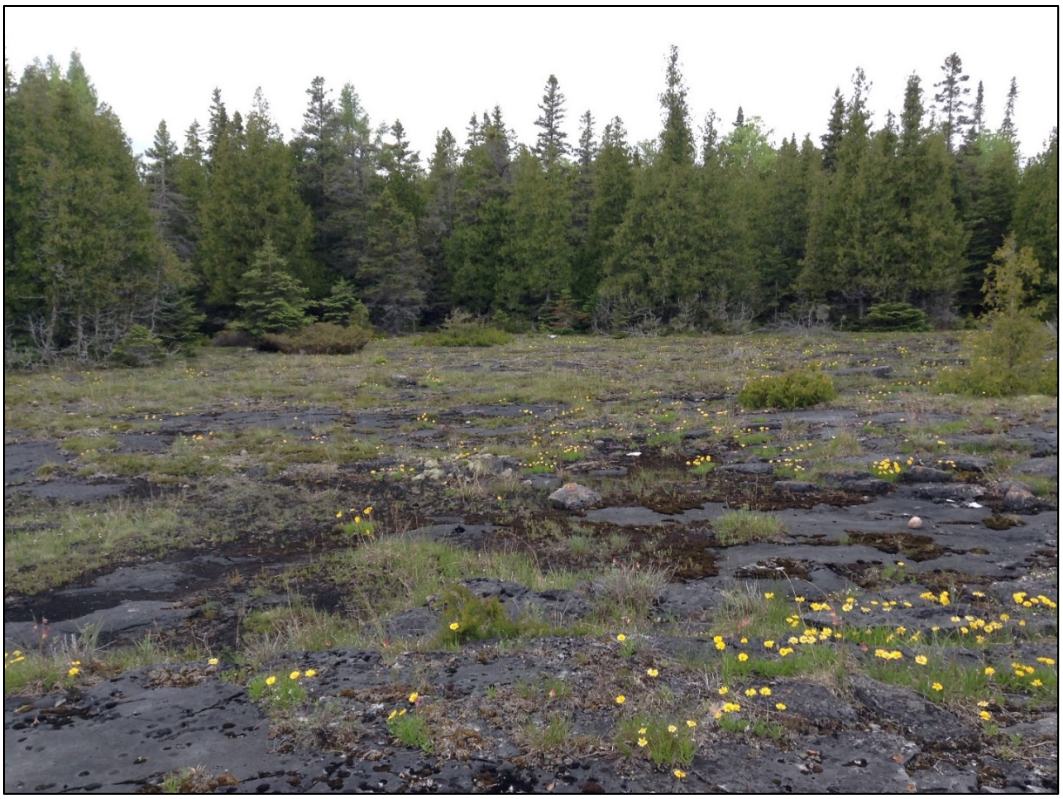

Figure 4. Habitat of Lakeside Daisy showing patches of mosses and lichens, and patches of exposed bedrock. Photo: Judith Jones. Photo may not be used separately from this document without permission of the photographer.

Lakeside Daisy is found in areas nearly bare of other vegetation, usually with the caudex and roots growing from cracks or crevices in the bedrock. The layer of soil on the bedrock surface and in the cracks is black and highly organic. The species also grows on small piles or layers of sand or gravel lying on the bedrock. It was found historically in deeper soils in Illinois prairies. It is usually absent or sparsely present in shaded, densely vegetated, or consistently mesic microhabitat.

Lakeside Daisy may be found within these alvar or bedrock vegetation types (Lee *et al.* 1998; Lee 2008):

ALO1-1 (RBOA1-1)	Dry Lichen – Moss Open Alvar Pavement
ALO1-3 (RBOA1-3)	Dry – Fresh Little Bluestem Open Alvar Meadow
ALS1-1 (RBSA1-1)	Common Juniper – Creeping Juniper – Shrubby Cinquefoil Shrub Alvar

ALS1-3 (RBSA1-3)	Scrub Conifer – Dwarf Lake Iris Shrub Alvar
ALT1-4 (RBTA1-4)	Jack Pine – White Cedar – White Spruce Treed Alvar
BBO2	Carbonate Bedrock Open Beach

Dominant species in the habitat of Lakeside Daisy include Northern Dropseed (*Sporobolus heterolepis*), Little Bluestem (*Schizachyrium scoparium*), Scirpus-like Sedge (*Carex scirpoidea*), and Twisted Moss (*Tortella tortuosa*), with shrubs such as Creeping Juniper (*Juniperus horizontalis*) and Shrubby Cinquefoil (*Dasiphora fruticosa*). A list of associate species found with Lakeside Daisy was provided in COSEWIC (2002). At least seven other at-risk and rare plant species are found in the same alvars with Lakeside Daisy (although not necessarily in the same microhabitat).

In three subpopulations on the Bruce Peninsula, Lakeside Daisy grows on top of large limestone blocks sitting on bedrock ledges on the Georgian Bay shoreline just above the high water level. Environmental conditions here are somewhat different from other Lakeside Daisy habitats in terms of temperature, humidity, wind, ice formation, etc.

Much of the habitat of Lakeside Daisy has a history of fire. On Manitoulin Island, almost all of the south shore on the western half of the island was reported as burned in the first land surveys between 1870-79 (Jones and Reschke 2005). This includes almost all of the areas where Lakeside Daisy is found on Manitoulin Island today. Despite evidence of past fire, no repeat fires have started in these habitats since the original land surveys (Jones and Reschke 2005; Jones unpublished oral history collected 1995-1996; Jones pers. obs.). If fire is involved in maintaining the habitat, it appears to be only at very long time intervals (a century or more). Only a few fires have started in adjacent habitat in the last 100 years, but these have been suppressed (Jones unpublished oral history collected 1995-1996), so it is not known whether a full-scale forest fire would have spread into existing habitat.

Alvars can be created by fire (Reshcke *et al.* 1999). The Silver Water Radio Towers site (one of two Lakeside Daisy sites not on the south shore) was completely forested prior to a large forest fire in 1925 (Jones and Reschke 2005). The site was described as "good level land with mixed timber" and "sandy loam of average depth and some large cedar" in the original land survey (Fitzgerald 1879a). A study of the fire history of limestone oak savannahs[3] on Manitoulin Island (Jones 2000), found most of the savannahs had been deciduous forests (maple, beech, basswood, etc.) with soil prior to a catastrophic forest fire in 1865. Thus, fire can remove soil and expose bedrock.

[3] Limestone oak savannah is a treed alvar vegetation community (Brownell and Riley 2000) with scattered Bur Oak (*Quercus macrocarpa*) trees, flora similar to alvar vegetation, shallow soil and occasional areas of exposed limestone bedrock (Jones 2000).

Jones (2000) found repeated fire had not maintained individual limestone oak savannahs and concluded the vegetation was maintained within the overall landscape by being occasionally created. It is possible the alvars which are habitat for Lakeside Daisy have the same dynamic, being created, lasting for a time, and eventually growing in with trees.

Total occupied habitat area (alvar polygons with Lakeside Daisy present) is currently around 608 hectares in the Manitoulin Island region and 46 hectares on the Bruce Peninsula.

Habitat Trends

Habitat is apparently being lost to natural succession over very long time frames. Notes in the first land surveys (Abrey 1878; Fitzgerald 1879a,b; Patton 1908) show the south shore of western Manitoulin Island was much more open 140 years ago than it is now (Reschke *et al.* 1999). On the Bruce Peninsula and Manitoulin Island, Lakeside Daisy is found in small, widely separated alvars that were likely once part of a more open landscape (Schaefer 1996). Anecdotally, some Lakeside Daisy habitat appears to have become much more vegetated and encroached by trees over a 20-year time period (Jones pers. obs. of Misery Bay West and Belanger Bay between 1995-2018).

A comparison of aerial imagery between the late 1940s and 1990 found that some alvar vegetation community types in which Lakeside Daisy is found changed little while others changed significantly over approximately 40 years (Jones and Reschke 2005). For example, alvars dominated by Creeping Juniper or Little Bluestem changed little, while alvar savannah/woodland dominated by White Cedar (*Thuja occidentalis*) or Jack Pine (*Pinus banksiana*) all changed noticeably. Thus, succession may be affecting Lakeside Daisy more quickly where it is growing in alvar savannah and woodland.

It may be difficult to track gradual change in habitat polygon boundaries, but small, isolated occurrences of Lakeside Daisy in limestone woodland probably indicate habitat loss. These woodland areas were described as open or barren land in the first land surveys 130 years ago. The small, isolated subpopulations at Lynn Point North, Lorne Lake, SW Silver Lake, Taskerville Northeast, George Lake S and George Lake SE subpopulations, as well as the small, scattered patches of plants in the trees on the northern boundaries of the Taskerville East and West subpopulations are probably remnants of formerly greater polygon size when habitat was more open. Some of these isolated occurrences are separated from other patches of alvar by several kilometres of forest, making it unlikely that the presence of Lakeside Daisy is the result of dispersal to that site from a larger alvar.

There is no indication that alvars containing Lakeside Daisy have been maintained by fire in the last 100 years, nor is any new habitat known to have been created other than at the Silver Water Radio Towers site. Therefore, with slight losses of habitat as woodland grows in but no compensating new formation of habitat, it can be presumed there is a long-term net loss. In woodland, this may take place in 20 to 40 years, whereas in open grassland it may be 40 years or more.

Shoreline habitat for the three shoreline subpopulations on the Bruce Peninsula may be becoming degraded from pedestrian traffic. This shoreline receives a large amount of use from visitors to Bruce Peninsula National Park, and the boulders which support Lakeside Daisy are sometimes subject to unsanctioned recreational climbing ("bouldering") (Miller pers. comm. 2019). This can dislodge the layer of mosses and organic matter that allows Lakeside Daisy to survive or which would provide sites for new establishment. The amount and rate of habitat loss is unknown, but the patches of suitable habitat are very small, so any loss may be significant for these subpopulations.

There has been a slight loss of habitat of unknown magnitude at four sites since the previous assessment. Some new cottages have been built in habitat at the Misery Bay West site, which has presumably caused a permanent loss of area and some fragmentation in the habitat. There has also been a small amount of habitat lost at the West of Lynn Point and Mississagi Lighthouse sites due to expansion of a quarry and the construction of new roads. Some habitat at the Burnt Island – Christina Bay and Emmett Lake Road sites has been damaged by vehicles. The amount of loss or permanency of the damage at these sites is unknown.

Lakeside Daisy is known to recolonize limestone shelves left after quarrying (DeMauro 1990) and to grow in trails once they stop being used (Jones pers. obs. of Misery Bay West). So far, there is no information on restoration of habitat, but it may be possible.

BIOLOGY

Life Cycle and Reproduction

In greenhouse conditions, Lakeside Daisy may grow from seed to a size large enough to flower (sexual maturity) in seven months. In natural conditions this may take two to three years (DeMauro 1990). Lakeside Daisy blooms from early May to early July, producing a single yellow inflorescence that is insect-pollinated. Seeds are dispersed four to six weeks after blooming. There is no period of seed dormancy, and new seedlings may appear through the summer during periods when the soil is moist. Seeds may remain viable for up to three years (DeMauro 1990). Flower buds are produced in late summer and overwinter to bloom the following spring.

Lakeside Daisy flowers are self-incompatible and must have pollen from a genetically different mate to set seed (DeMauro 1993; Campbell 2001). Wallace *et al.* (2016) examined flower heads at five sites on Manitoulin Island and found more than 80% had successfully set seed, showing that there was probably no lack of mate diversity at those sites. However, no small subpopulations (fewer than 100 plants) were studied where appropriate mating types might be limited. Small subpopulations in Illinois apparently became extirpated due to a lack of mate diversity (DeMauro 1993). More information about self-incompatibility and genetic diversity of mates can be found in COSEWIC (2002).

It seems appropriate to treat the genet (a cluster of connected ramets or clones) as a mature individual rather than the ramet, as is recommended for most analyses of vascular plants (COSEWIC 2017; IUCN 2019). In Lakeside Daisy, single ramets are attached to a woody caudex and are unlikely to separate and survive alone. In addition, due to self-incompatibility, the ramets within a genet cannot breed with each other, and mating diversity in small subpopulations may be a limitation. While multiple ramets may increase the likelihood of a genet's survival and sexual reproduction, in adverse conditions, fewer genotypes means a loss of future mating potential similar to a loss of mature individuals. Thus, the number of genotypes present corresponds to the number of mature individuals.

Small occurrences of a few clusters of ramets have been observed informally at the Silver Water Radio Towers site for more than 30 years (Morton and Venn unpublished data) and at Lorne Lake for at least 40 years (Jones unpublished data). The plants at these sites have not disappeared nor have new plants established in other parts of the habitat. Based on this, it is presumed that Lakeside Daisy plants may live several decades. Campbell (2001) found that fewer than 5% of ramets died during a one-year demographic survey. As well, most clusters have several to many ramets (more than just a few years' growth).

The average age of individuals in the population is not known but is probably at least 10 years and very likely much longer. In a two-year study of plots of 150 ramets, Campbell (2001) tracked the proportion of ramets at three life stages: 4-6 leaves, >6 leaves, and flowering. From proportions at each stage she calculated generation time (the mean age at which new plants produced offspring) as 10.78 to 21.08 years with 16 years as the average.

Physiology and Adaptability

Lakeside Daisy appears to tolerate great extremes of habitat conditions and grows in alkaline conditions found on the surface of limestone. Lakeside Daisy has been successfully grown in gardens and greenhouses, including for ornamental use (DeMauro 1990; Ault 2002).

Dispersal and Migration

The seed-like fruits of Lakeside Daisy are dispersed by gravity or wind (DeMauro 1990). The fruits do not have any particular adaptation to assist with dispersal, having a pappus of scales rather than plumose bristles, and no hooks or barbs. Potential dispersal distance is unknown, but seedlings are most dense within one metre of adult plants (DeMauro 1990).

Subpopulations on Manitoulin Island are not severely fragmented, as defined by COSEWIC, as there are many very large habitats supporting extensive subpopulations, and, although they are separated by forested land, the separation distances between subpopulations are not great (on the order of one to a few km). On the Bruce Peninsula, even subpopulations in the smallest habitats still have >1000 ramets (perhaps ~50 individuals) and are still presumed to have sufficient mate diversity to be viable.

Accordingly, at this time, the total Canadian population is not considered severely fragmented. (See **Fluctuations and Trends** for more information on viability of subpopulations**.)**

Interspecific Interactions

Lakeside Daisy receives a great variety of insect visitors. Campbell (2001) studied plants at 13 sites on the Bruce Peninsula and observed a total of 41 taxa, from eight orders (Hymenoptera, Diptera, Lepidoptera, Neuroptera, Homoptera, Hemiptera, Coleoptera, Orthoptera) although some were probably not pollinators. Studies of Lakeside Daisy suggest that bees (Apidae, Halictidae) are particularly important for pollination (DeMauro 1993), although flies were found to be much more prevalent flower visitors (Campbell 2001). Campbell and Husband (2007) found smaller populations were not pollen-limited because they received more insect visitors.

COSEWIC (2002) noted herbivory, mainly by native species, as having a noticeable effect on Lakeside Daisy in 1999-2000. Herbivores included a range of insects, White-tailed Deer (*Odocoileus virginianus*), seed-eating birds, Eastern Cottontail (*Sylvilagus floridanus*), and seed-eating larvae. However, subsequent field studies did not find much impact (Parks Canada Agency 2011). Herbivory seems to vary from year to year and site to site (COSEWIC 2002) with very localized effects (Jones pers. obs.). It is unknown whether any herbivores (seed predators) may also be dispersal vectors for Lakeside Daisy.

Exotic plant species, such as Common St. John's Wort (*Hypericum perforatum*), Mossy Stonecrop (*Sedum acre*), Canada Bluegrass (*Poa compressa*), and White Sweet-clover (*Melilotus albus*) have been cited as having an effect on Lakeside Daisy (Parks Canada Agency 2011). Wallace *et al.* (2016) studied encroachment of Lakeside Daisy by exotic species. They found exotics were widespread, but there were very few instances where exotics were close to Lakeside Daisy plants. However, the lack of success of Illinois restorations seems to have been due in part to invasion by exotic species as well as to herbivory (DeMauro 1990), so perhaps these interactions may have effects in very localized areas where they occur.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Since COSEWIC (2002), new fieldwork has been done with estimates or detailed counts of abundance. Jones surveyed localities on Manitoulin Island not visited for decades or presumed to be erroneous (Jones 2004, 2005, 2015; NHIC 2018). McGuire (2006) surveyed six subpopulations on the Bruce Peninsula and conducted detailed counts. Jalava (2008) surveyed three subpopulations on the Bruce Peninsula including one discovered in 2006. Wallace *et al.* (2016) conducted high-precision counts and base-line monitoring on Manitoulin Island in all or parts of 13 subpopulations.

For this report, mapping was reviewed for more than 600 observations in the NHIC (2018) database ranging from the 1950s to 2018. These observations also included recent records from iNaturalist. Additional data from experts and non-governmental organizations were mapped. All occupied habitat polygons were mapped and an evaluation of polygons belonging to each subpopulation was made using a 1 km separation distance to define subpopulations. In some places new survey data have found Lakeside Daisy patches in the 1 km separation distance between previously separated occurrences, causing the occurrences to be combined into single but larger subpopulations. Three subpopulations have been discovered since 2002 and three previously known subpopulations were not included in COSEWIC (2002) (Table 1).

The number of subpopulations in COSEWIC (2002) was not determined using a standard separation distance, and there were multiple entries for many of the subpopulations delineated in the current report. For example, five previous localities are within the current subpopulation at Overhanging Point; four within Carroll Wood Bay, four within Misery Bay West, three within Dyers Bay Road, etc. Thus, the lower number of subpopulations in the current report does not constitute a decline since 2002 but rather reflects different methodology.

Precise counts of Lakeside Daisy are difficult to make because it is a colonial, rhizomatous species that can be very abundant. Without genetic work it is nearly impossible to determine which ramets or groups of ramets belong to a single genet. Tepedino (2012) suggested that estimates of abundance of clonal plants are frequently overestimated and recommended most estimates be reduced by approximately 25-50%. In addition, he noted that determining the number of individuals is especially tricky for self-incompatible clonal species, and that in addition to genetic studies, ramet-genet ratios and spatial distribution of genets may need to be considered but that these are difficult and expensive to determine. Such studies have not been conducted for Lakeside Daisy.

Several methods have been used to estimate abundance. Some observers have chosen to count flowering scapes, but this is not a good measure. Observational data (NHIC database 2018) show the amount of flowering varies greatly from year to year for the same subpopulation, and the trigger for flowering is not well known. It may be based on ramet size (DeMauro 1993), but that may depend on environmental factors. This might mean there would be more flowering in hotter or sunnier years, not due to declines or increases. Also, some subpopulations may be growing very well vegetatively and produce few flowers.

The method used by Campbell (2001) involved counting flowering scapes along 1 m wide transects spaced 20 m apart and then extrapolating to the area of the polygon. It is not known how the resulting estimates of flower stems were translated into estimates of vegetative ramets. Other observers have estimated numbers of ramets, which can at least be used to track subpopulation change over time even if it does not correspond to numbers of mature individuals.

Campbell (2001) was the basis of the abundance information used in COSEWIC (2002). Abundance values reported by Campbell are much larger, sometimes by several orders of magnitude, than counts of the same subpopulations by other people in the following five years. Campbell's counts are consistently very much larger for all sites, even for small subpopulations where abundance can be more accurately determined. The difference in counts is definitely not due to declines as most sites are undisturbed and show little or no obvious mortality, especially on the scale that would be necessary to explain the discrepancies.

For several subpopulations, counts/estimates by Jones (2004, 2005, 2015), McGuire (2006), Wallace *et al.* (2016), and others (NHIC 2018) are approximately similar to each other and are deemed more realistic than the abundance data of Campbell (2001).

Comparison of abundance values in the Recovery Strategy for Lakeside Daisy in Canada (Parks Canada Agency 2011) with those in Table 1 indicate that some values in the Recovery Strategy were misreported or misinterpreted. For these reasons, numbers in Table 1 should be considered more accurate and may not match those in the Recovery Strategy.

Abundance

Table 1 shows abundance (number of ramets) in all subpopulations with the date of the most recent estimate and the name of the observer. Approximately 4,279,000 ramets in the Manitoulin Island region and approximately 84,500 on the Bruce Peninsula are documented for a total of 4,363,500 ramets. This estimate is presumed to be more accurate than simply reducing previous abundance by 25 to 50% (following the suggestion of Tepedino [2012]) because previous abundance has been found to be greatly inaccurate, and because the current estimate is based on actual hand-counts of the number of ramets in some clusters. If 20 to 50 ramets are estimated to occur on a mature individual (Jones pers. obs.), there may be somewhere between 87,000 and 220,000 mature individuals in Canada. There are a few areas of unsurveyed habitat on Manitoulin Island where presence is highly probable. Therefore, the presumed total abundance may be closer to or upwards of the higher number.

Fluctuations and Trends

There are 12 subpopulations or parts of subpopulations with more than one observation on which to base a comparison of abundance. Table 2 shows the available trend data. Four subpopulations show decreases, six are stable, and two are stable or may have increased. One subpopulation shows a huge increase, but this is likely a calculation or reporting error (Wallace pers. comm. 2019).

Table 2. Broad trend data for 12 subpopulations or parts of subpopulations. Some recent counts may cover only part of a subpopulation (e.g., only critical habitat polygons), so recent abundance in Table 2 may not be the same as the total abundance given in Table 1.

Subpopulation (or part) Name	Previous Abundance	Most Recent Abundance	Net Trend	Comments
Burnt Island Harbour	10,000s Jones 2000	33,000 Wallace *et al.* 2016	Stable	
Christina Bay	5260 Jones 2011	433,790 Wallace *et al.* 2016	Error?	Suspect Wallace error; value is very large for 8 ha
Misery Bay East	1000s Jones 2000	3,666 Wallace *et al.* 2016	Stable	
Mississagi Lighthouse	3000-5000 Oldham 1994	1,724 Wallace *et al.* 2016	Decrease	
Murphy Point	3000-5000 Oldham 1994	13,390 Wallace *et al.* 2016	Increase?	No previously defined polygon, so not a tight comparison; unknown what size area was originally counted
Quarry Bay	10,000s Jones 1995	77,680 Wallace *et al.* 2016	Stable	
Rickley Harbour	>60,000 Jones 2006	126,725 Wallace *et al.* 2016	Stable or increase	Jones very loose estimate of 10,000s at 6 observation points
Silver Water Radio Towers	20 "clusters of rosettes" Jones 1995	458 Wallace *et al.* 2016	Stable	Assume ~20 ramets per cluster
SW of Silver Lake	>10,000 Jones 2005	7083 Wallace *et al.* 2016	Decrease	
West of Lynn Point	>100,000 Jones 1995	77,591 Wallace *et al.* 2016	Decrease	
West of Sand Bay	~5000 Jones 2010	4,083 Wallace *et al.* 2016	Stable	
Cabot Head	1000s Varga 1993	~10,000 McGuire 2006	Stable	
George Lake Alvar	1000s Schaefer 1995	400 Miller 2017	Decrease	Counts may cover slightly different areas but polygon is only 5 ha

The initial observations for all these subpopulations are very broad estimates (1000s, 10,000s, etc.) and the sizes of the areas that are being compared may not be identical, so these are only broad trends. It is probably not meaningful to try to infer a percentage or rate of decline from the change in values. Extrapolation from these 12 subpopulations to an overall trend for all 34 Canadian subpopulations is untenable, especially when some of the largest subpopulations have no trend data. Regardless of precision, these data show that it is possible for subpopulations to remain fairly stable for decades.

Presence/absence data show that even small subpopulations seem to be very long-lived. No subpopulations are known to have disappeared in the history of observation. Two Manitoulin Island occurrence sites have not been visited since the original observations (1961 and 1976), but suitable alvar habitat is still visible on satellite imagery so both are still considered extant.

Because the initial range of population estimates is so broad, it would be possible for a different trend to be interpreted for most of the subpopulations deemed stable. However, the observations of only very slow change in habitat size and shape at most sites, the fact that even small subpopulations can be very long-lived, and little or no observed damage to these subpopulations all support the interpretation of stability.

Rescue Effect

Rescue effect is considered improbable for this species. The nearest American subpopulation is a very small roadside occurrence in the Upper Peninsula of Michigan, more than 130 km across Lake Huron. The subpopulation in Ohio is more than 400 km to the south. A propagule would need to travel across all of the land of southern Ontario to reach the Canadian population. Suitable alvar habitat exists in Canada on Pelee Island, only 17 km away from the Kelleys Island, Ohio subpopulation, but Lakeside Daisy has never been seen on Pelee Island (Burgess 1889; Macoun 1893; Duncan *et al.* 2011).

THREATS AND LIMITING FACTORS

Threats

The main threats to Lakeside Daisy (Appendix 1) are threats to its alvar habitat. Threats include: trampling by pedestrians, off-road vehicle use, building and road construction, quarrying, logging in adjacent forests and invasion by exotic species. In addition, filling in of habitat due to fire suppression and changes in climate may potentially be affecting habitat over very long time frames.

Direct threats to Lakeside Daisy assessed in this report were organized and evaluated based on the IUCN-CMP (World Conservation Union-Conservation Measures Partnership) unified threats classification system (Master *et al.* 2012). Threats are defined as the proximate activities or processes that directly and negatively affect the population. Results of the impact, scope, severity, and timing of threats are presented in tabular form in Appendix 1. The overall calculated and assigned threat impact to Lakeside Daisy is Medium to Low. Threats are presented in the order they appear in Appendix 1. A table showing site by site threats information was also presented in Parks Canada Agency (2011).

1 Residential & Commercial Development

1.1 Housing and Urban Areas—Building and Road Construction [Low impact]

Shoreline property in private ownership in parts of five subpopulations could potentially be developed for cottaging. Although there are policies in place that should prevent development in species at risk habitat, four subpopulations are in unorganized townships where there is little or no oversight of construction. Many of these properties are in the hands of the older generation, and as ownership is passed on to younger family members, likely over the next 10 years, development and construction of new cottages may become desirable.

3 Energy Production & Mining

3.2 Mining and Quarrying [Low impact]

Four subpopulations on western Manitoulin Island are in the extraction area of a large quarry. Although the mitigation design prevents extraction in the habitat of Lakeside Daisy, plants may still be affected by dust and by changes in environmental parameters as the land surrounding the habitat is extracted. One small subpopulation will likely be destroyed. Extraction will happen gradually over the next 30 years. Boulder removal with heavy machinery has been cited as a general threat to alvar habitats, and noted as becoming more common on the Bruce Peninsula (Parks Canada Agency 2011). So far, this activity has not been observed in the habitat of Lakeside Daisy.

5 Biological Resource Use

5.3 Logging & Wood Harvesting [Low impact]

Damage and loss of Lakeside Daisy and its habitat occurs when alvars adjacent to logging operations are used as staging areas for logs, machinery and vehicles, and personnel trailers. This is an ongoing but sporadic possibility in the privately owned parts of seven subpopulations. Historical damage to Lakeside Daisy from logging is still visible at Quarry Bay, Belanger Bay, and Lynn Point, where piles of bark and woody debris cover areas of limestone bedrock.

6 Human Intrusions and Disturbance

6.1 Recreational Activities—Trampling, Off-road Vehicle Use [Low impact]

Recreational activities in the habitat of Lakeside Daisy are a threat because human use may trample vegetation and dislodge shallow soils. Such activities also may introduce non-native and invasive species into the habitat (discussed in 8.1, below). Recreational activities may include off-trail ATV use and unsanctioned camping on Manitoulin Island, off-trail nature appreciation in parks and private nature reserves on the Bruce Peninsula, and bouldering and off-trail hiking activities at the shoreline subpopulations in Bruce Peninsula

National Park. Although damage or loss from recreational activities may only affect 1.3 % of total population, they could affect up to 24% of Bruce Peninsula abundance.

7 Natural System Modifications

7.1 Fire Suppression [Low impact]

Without wild fire, the density of vegetation in alvar habitats increases. However, this appears to happen over long time frames (>40 years). There has been almost no fire in the habitat of Lakeside Daisy in more than 100 years, so a slow increase in vegetative cover potentially threatens the entire Canadian population. The threat may be greater where Lakeside Daisy occurs in alvar woodland (where it could become completely shaded in relatively shorter time frames) than in the centre of large, sparsely vegetated habitats. Historically, it is possible the occurrence of large forest fires was a limiting or controlling factor in creating habitat for Lakeside Daisy. As fire is now suppressed, the lack of fire is considered a threat.

8 Invasive & Other Problematic Species & Genes

8.1 Invasive Non-Native/Alien Species [Low impact]

Exotic plant species may compete with Lakeside Daisy and alvar associated species for resources, light and growing space and may also change habitat dynamics if they increase biomass accumulation on the surface of nearly bare bedrock. Non-native species are present in parts of all subpopulations, usually at least along trails. Mossy Stonecrop and Common St. John's Wort in particular are able to grow very densely in the moss cushions and bedrock crevices required by Lakeside Daisy. Wallace *et al.* (2016) examined non-native species in the habitat of Lakeside Daisy and found Common St. John's Wort at 33% of their study sites and Mossy Stonecrop at 44% of study sites. Canada Bluegrass, White Sweet Clover, Common Mullein (*Verbascum thapsus*), and Ox-eye Daisy (*Leucanthemum vulgare*) are also sometimes very abundant in Lakeside Daisy habitat (Jones pers. obs.).

11 Climate Change

11.3 Storms and Flooding [Unknown impact]

The effects of climate change are unknown, but changes in weather patterns, especially those that affect Lake Huron, could be a threat. More severe winter storms may increase wave-wash and ice buildup into the habitat of Lakeside Daisy.

Limiting Factors

Lakeside Daisy flowers are self-incompatible and must have pollen from a genetically different mate to set seed. Campbell (2001) found the species was not pollen-limited in 1999. However, with the recent decline in insect pollinators (Potts *et al.* 2010), it is possible pollination may now be a limitation.

The water level in Lake Huron – Georgian Bay rises and falls naturally over approximately 30-year cycles, with 150-year extremes (Quinn and Sellinger 2006; Wilcox *et al.* 2007). During years of low water levels, large areas of bedrock shoreline become exposed and are colonized by Lakeside Daisy. When water levels rise, these plants get washed away, and at the highest water levels some subpopulations may be greatly reduced in area and abundance. In 2019, along the south shore of Manitoulin Island, high water in Lake Huron had inundated 50 to 100 m of shoreline (measured from the former water's edge inland to the trees) which had been exposed since the late 1990s (Jones pers. obs). This area includes the lakeward-most parts of many subpopulations that extend onto the shore, such as Lynn Bay, West of Lynn Point, Greene Island, and others. Lakeside Daisy seems to be able to survive and recover from these cyclical losses, but water levels may be a limiting factor.

Number of Locations

There are 29 locations in Canada. In the Manitoulin Island region, the following subpopulations form one location as they are adjacent to a large, expanding quarry where all could receive damage from dust and construction of new roads.

- Mississagi Lighthouse
- West of Lynn Point
- Lynn Bay
- Lynn Point North

On the Bruce Peninsula, the following subpopulations form one location. They are on limestone blocks on the shoreline. A single day of high visitation from people all wanting to climb boulders would cause serious damage and is a plausible threat.

- Overhanging Point – The Grotto
- West of Cave Point
- Halfway Log Dump – West of Cave Pt.

The remaining 27 subpopulations in the rest of the Canadian population are not likely to be affected by the same threat at the same time or at the same rate and therefore would constitute 27 separate locations.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Lakeside Daisy is listed as Threatened on Schedule 1 of the federal *Species at Risk Act*. It is listed in Ontario as Threatened on the Species at Risk in Ontario (SARO) List under the *Endangered Species Act, 2007*. In the United States, the species is federally listed as Threatened. It is not listed by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and has not been assessed by the IUCN Red List.

Since the 2005 federal designation as Threatened, critical habitat has been identified within a federal Recovery Strategy (Parks Canada 2011) in protected areas, comprising 236.2 ha on Manitoulin Island (38% of Manitoulin Island region Lakeside Daisy habitat area) and 23.9 ha on the Bruce Peninsula (67% of Bruce Peninsula Lakeside Daisy habitat area). Parks Canada Agency (2011) describes the methods and criteria used to identify critical habitat and the recovery actions completed or underway as of that date. Despite legal protection for critical habitat, most of these areas have little or no effective mechanism to prevent damage to plants or habitat, and damage does occur (Miller pers. comm. 2019; Jones pers. obs.).

A new official plan has been developed for the Manitoulin District (Manitoulin Planning Board 2018) which restricts development and site alteration in alvars. However, this policy is often disregarded by individual municipalities (Jones pers. obs.), and some Lakeside Daisy subpopulations are in unorganized townships where there is little or no oversight on new construction. No other prohibitions or recovery actions have been implemented.

Non-Legal Status and Ranks

Lakeside Daisy has been ranked as follows (NatureServe 2019):

Globally	G3 – Vulnerable
Nationally	N1 - Critically Imperilled in the U.S. N3 - Vulnerable in Canada
Subnationally	S1 - Critically Imperilled in Illinois, Michigan, and Ohio S3 - Vulnerable in Ontario.

Habitat Protection and Ownership

Table 3 shows site by site ownership for subpopulations of Lakeside Daisy. Ownership is summarized here.

Protected Areas

Ontario Parks	~270 ha of habitat in Misery Bay and Queen Elizabeth Queen Mother M'nidoo M'nising Provincial Parks
Parks Canada Agency	~43 ha of habitat in Bruce Peninsula National Park with Cabot Head Provincial Park (managed by national park)
Non-governmental organizations (Nature Conservancy Canada, Ontario Nature, and Escarpment Biosphere Conservancy)	~40 ha at Taskerville East, Taskerville West, Dyer's Bay, Quarry Bay, and East of Black Point)
Total:	353 ha

Other Ownership

Private ownership	~225 ha
Corporate ownership	~71 ha around Lynn Point, Mississagi Lighthouse
Crown	~4 ha shoreline allowances in unorganized townships
Municipality of Burpee-Mills	~1 ha shoreline allowance at Taskerville East
First Nation	~0.5 ha at Emmett Lake Road

Three new private nature reserves containing Lakeside Daisy have been protected on Manitoulin Island since 2002.

Table 3. Ownership of Lakeside Daisy subpopulations with percentage owned if subpopulations have multiple ownership, and area (ha) of critical habitat if identified in Parks Canada Agency (2011). Critical habitat polygons are in protected areas and on Crown land only.

Subpopulation Name Manitoulin Region listed west to east; Bruce Peninsula listed alphabetically	Ownership	Percentage owned if multiple owners (approx.)	Area of critical habitat polygons (ha)
Belanger Bay West & East	Ontario Parks		63
Burnt Island Harbour - Christina Bay	Ontario Parks, Private	96, 4	16.8
Burnt Island Shoreline	Crown		
Carroll Wood Bay	Private, Crown	97, 3	
East of Black Point - Fisher Bay	Private, NGO, Crown	58, 36, 6	11.3
Girouard Pt. - Rickley Harbour	Ontario Parks, Private	88, 12	15
Greene Island	Crown		1.4
Lorne Lake	Private		
Lynn Bay	Private, Crown	98, 2	
Lynn Point North	Corporate		
Misery Bay East	Ontario Parks		11.4
Misery Bay North	Private		
Misery Bay West	Private, Ontario Parks	69, 31	74
Mississagi Lighthouse	Corporate		
Murphy Point	Private		
Quarry Bay	Ontario Parks, Private, NGO	69, 28, 3	42.7
Silver Water Radio Towers	Private		
SW of Silver Lake	Ontario Parks		0.6
Taskerville Centre	Private		
Taskerville East - Bay W of Portage Bay	Private, Municipal	94, 6	
Taskerville Northeast	Private		
Taskerville West	NGO		
West of Lynn Point	Corporate		
West of Sand Bay	Private		
Cabot Head	Parks Canada, Ontario Parks		4.9
Dyer's Bay Road - Bruce Alvar Nature Reserve	NGO, Parks Canada	65, 35	8.2
Emmett Lake Rd	First Nation		0.2
George Lake Alvar	Parks Canada		5.3
George Lake South	Parks Canada		0.3

Subpopulation Name Manitoulin Region listed west to east; Bruce Peninsula listed alphabetically	Ownership	Percentage owned if multiple owners (approx.)	Area of critical habitat polygons (ha)
The Grotto - Overhanging Point	Parks Canada		2.2
Halfway Log Dump - Cave Point	Parks Canada		1.3
South East of George Lake	Private		1.1
West of Cave Point - ENE of Horse Lake	Parks Canada		0.4

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BIOGRAPHICAL SUMMARY OF REPORT WRITER(S)

This report was prepared by Judith Jones, Winter Spider Eco-Consulting. Jones documented alvars and Lakeside Daisy as part of the International Alvar Conservation Initiative in 1995-1996 and in a life science inventory of Manitoulin provincial parks in 2000. She assisted with the preparation of the Recovery Strategy for Lakeside Daisy (Parks Canada Agency 2011) including mapping of critical habitat. Jones has visited all major alvars in the Manitoulin District. She also works extensively on other species at risk and has written six COSEWIC status reports and more than 30 recovery strategies. Her work also

includes environmental impact studies (EIS) for development proposals and on-the-ground control of invasive species. She has lived on Manitoulin Island since 1988.

COLLECTIONS EXAMINED

None

Appendix 1. Threats calculation for Lakeside Daisy.

THREATS ASSESSMENT WORKSHEET				
Species or Ecosystem Scientific Name	*Tetraneuris herbacea - Lakeside Daisy*			
Element ID		**Elcode**		
Date :	13/09/2019			
Assessor(s):	Judith Jones (report writer), Dave Fraser (facilitator), Del Meidinger, Colin Jones, Karolyne Pickett, Sue Meades, Bruce Bennett, Kelsey Marchand, Esme Batten, Jarmo Jalava, Karen Hopper, Angele Cyr			
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	6	6
Calculated Overall Threat Impact:			Medium	Medium
Assigned Overall Threat Impact:			**CD = Medium - Low**	
Impact Adjustment Reasons:			As some Low Impact threats were considered to be at the low end of the range of scope or severity, it is possible that the Threat Impact could range into the Low Threat impact outcome; hence, the overall threat impact is scored as Medium to Low.	
Overall Threat Comments			Large subpopulations on western Manitoulin Island buffer the effects of threats on smaller subpopulations elsewhere. Three generations: 33-63 years; average 48 years.	

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development	D	Low	Small (1-10%)	Serious (31-70%)	Moderate - Insignificant/Negligible	
1.1	Housing & urban areas	D	Low	Small (1-10%)	Serious (31-70%)	Moderate - Insignificant/Negligible	Parts of 4 subpopulations in private ownership in unorganized township where there is little or no oversight to prevent construction in habitat of Lakeside Daisy. Older generation currently owns these properties and as younger generation inherits them (0 to 15 years?) development may occur. There are restrictions on development of alvars but not always enforced. Several private sites have shoreline habitat. Shoreline development would have higher impact than development of inland 100 acre lots where alvars are usually smaller. Low end of scope range but greater than 1%
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture						
3	Energy production & mining	D	Low	Small (1-10%)	Serious - Moderate (11-70%)	Moderate (Possibly in the short term, < 10 yrs)	
3.1	Oil & gas drilling						
3.2	Mining & quarrying	D	Low	Small (1-10%)	Serious - Moderate (11-70%)	Moderate (Possibly in the short term, < 10 yrs)	Refers to effects of gradual expansion of Lafarge Quarry on western Manitoulin Island. Mitigation design prevents extraction in habitat; however, subpopulations may still receive effects from dust and changes in environmental parameters. One small subpop will likely be destroyed [3.7 ha site with no species abundance data]. Extraction is expected to take 30 years to complete. Timing is moderate because although mining is ongoing, activities have not yet arrived in the area to be impacted. Subpopulations potentially affected: Lynn Point North, West of Lynn Point, Mississagi Lighthouse.
3.3	Renewable energy						
4	Transportation & service corridors		Negligible	Negligible (<1%)	Serious (31-70%)	High (Continuing)	
4.1	Roads & railroads		Negligible	Negligible (<1%)	Serious (31-70%)	High (Continuing)	Threat of roadside occurrences getting run over. Scope is negligible for total population but could be up to 4% of Bruce Peninsula abundance, which would change this threat to Low for the Bruce Peninsula area. Includes road maintenance. Dust especially an issue for Emmett Road subpopulation; portion that is on the road shoulder could experience high impact; the actual damage from dust is of unknown impact and may depend on when in plant life cycle damage takes place.
4.2	Utility & service lines						
4.3	Shipping lanes						
4.4	Flight paths						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5	Biological resource use	D	Low	Small (1-10%)	Extreme - Serious (31-100%)	Moderate (Possibly in the short term, < 10 yrs)	
5.1	Hunting & collecting terrestrial animals						Some collecting for use in gardens but impact is considered negligible.
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting	D	Low	Small (1-10%)	Extreme - Serious (31-100%)	Moderate (Possibly in the short term, < 10 yrs)	This is an ongoing possibility in privately owned parts of any subpopulation, but very unlikely that threat would occur to all sites at once. Damage or loss occurs when alvars adjacent to logging operations are used as staging for logs, machinery, and personnel trailers. Impact of staging is evident from sites impacted decades ago. Logging activities themselves usually do not directly impact; it is the choice of alvar as the landing site. Subpopulations potentially affected: any on privately owned land.
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance	D	Low	Small (1-10%)	Serious (31-70%)	High (Continuing)	
6.1	Recreational activities	D	Low	Small (1-10%)	Serious (31-70%)	High (Continuing)	Refers to trampling from ATV use on Manitoulin Island, recreational nature appreciation in Bruce parks and private nature reserves, and bouldering and hiking activities in Bruce National Park. Also unsanctioned camping. NOTE: although this impacts only 1.3 % of total population, it could be up to 24% of Bruce abundance. Emmett Road subpopulation has significant impact from inappropriate ATV use. Subpopulations potentially affected: any or all but unlikely to impact all subpopulations simultaneously.
6.2	War, civil unrest & military exercises						
6.3	Work & other activities						
7	Natural system modifications	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.1	Fire & fire suppression	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Effects of natural succession and changes in habitat due to lack of fire. Whole population is impacted by succession but at different rates depending on sparseness or woodiness of surrounding alvar vegetation. Larger, open alvars may be impacted over >50 years, outside time frame of assessment, but smaller habitat patches in woodland could be lost within 20-30 years. Largest subpopulations still have much open habitat, thus restricted scope and slight severity within 10 years/3 generations. In high/continuing timing, succession is affecting plants in outer parts of alvars (the transition from alvar to woodland to forest). Subpopulations potentially affected: any or all but is not impacting all subpopulations at the same rate.
7.2	Dams & water management/use						
7.3	Other ecosystem modifications						
8	Invasive & other problematic species & genes	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
8.1	Invasive non-native/alien species	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	*Sedum acre, Hypericum perforatum*, knapweed, and other weeds, present just about everywhere to some extent, in some parts of all subpopulations, especially along trails. Wallace *et al.* (2016) found few places where invasives were within 10 cm of Lakeside Daisy. Still, widespread presence of weeds is likely to have some effect--hence slight rather than negligible severity.
8.2	Problematic native species						
8.3	Introduced genetic material						
9	Pollution						
9.1	Household sewage & urban waste water						
9.2	Industrial & military effluents						
9.3	Agricultural & forestry effluents						
9.4	Garbage & solid waste						
9.5	Air-borne pollutants						
9.6	Excess energy						
10	Geological events						
10.1	Volcanoes						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
11.1	Habitat shifting & alteration		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Higher temperatures and drought may not affect this species directly and may even affect it positively if they kill off competing vegetation and increase bare alvar. However, increased precipitation could allow different species to survive, increasing competition and vegetation growth. Habitat may no longer be suitable. In general effects of climate change are unknown.
11.2	Droughts						Drought not considered a direct threat to Lakeside Daisy
11.3	Temperature extremes						Temperature extremes not considered a direct threat to Lakeside Daisy
11.4	Storms & flooding		Unknown	Restricted - Small (1-30%)	Unknown	Moderate (Possibly in the short term, < 10 yrs)	There is a "natural" cycle of high and low water levels in Lake Huron. Whether cycles continue or water continues to rise or fall permanently is unknown. Higher temperatures could result in more evaporation and lake levels could drop. Or greater evaporation could result in more precipitation. Scope over 10 years is uncertain. If lake levels continue up and down, species may be inundated but may recolonize new habitat when water recedes; if levels change permanently, then greater impact. Not certain of timing or impact of flooding but considered possible in short term. Subpopulations potentially affected: nearly all, because most are situated on the Lake Huron/Georgian Bay shoreline.

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