COSEWIC
Assessment and Status Report

on the

Annual Saltmarsh Aster
Symphyotrichum subulatum

in Canada

NOT AT RISK
2017

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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Previous report(s):

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Flanders, G. JR., and H. Hinds. 1992. COSEWIC status report on the Annual Saltmarsh Aster *Symphyotrichum subulatum* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 13 pp.

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COSEWIC
Assessment Summary

Assessment Summary – April 2017

Common name
Annual Saltmarsh Aster

Scientific name
Symphyotrichum subulatum

Status
Not at Risk

Reason for designation
This species typically occurs in brackish marsh and river shores. The species was previously assessed as Special Concern. Based on a revised taxonomy, it is now known to be more widely distributed in Canada, with subpopulations in Quebec, New Brunswick and Prince Edward Island. In addition, extensive targeted field work has discovered numerous new occurrences. There is no current evidence of population decline or unnatural fluctuations and no significant threats appear to affect the species.

Occurrence
Quebec, New Brunswick, Prince Edward Island

Status history
Designated Special Concern in April 1992. Status re-examined and designated Not at Risk in April 2017.

COSEWIC
Executive Summary

Annual Saltmarsh Aster
Symphyotrichum subulatum

Wildlife Species Description and Significance

Annual Saltmarsh Aster (previously assessed by COSEWIC as Bathurst Aster) is a small annual herb of brackish marshes and shores. In Canada, it is typically under 30 cm, and often under 10 cm tall, though it can grow much larger in the U.S.A. Stems are typically extensively branched with 5-60 heads (clusters of tiny bluish-white ray florets and yellow disk florets) in a pyramidal inflorescence. The short ray florets distinguish this species from co-occurring aster species.

Canadian occurrences represent the northernmost native subpopulations, 450 km north of the nearest United States occurrences. Most subpopulations in Atlantic Canada exhibit characteristics somewhat distinct from plants occurring elsewhere, and were formerly recognized as an endemic Canadian variety called Bathurst Aster that is no longer considered taxonomically distinct. Annual Saltmarsh Aster co-occurs with numerous provincially rare and several nationally rare southern coastal species on the relatively warm shores of the Gulf of St. Lawrence.

The species has been investigated for anti-oxidative and anti-inflammatory activity.

Distribution

The species occurs widely in the eastern and southwestern United States, the Caribbean, Central and South America and is extensively introduced worldwide. The Canadian variety *subulatum* occurs from southeastern Quebec, New Brunswick, and Prince Edward Island along the Atlantic coast to southern Texas, and more locally inland in eastern North America. Occurrences in southern Ontario and many inland regions of the United States are introduced.

Habitat

Annual Saltmarsh Aster typically occurs in tidally influenced brackish estuarine marsh and river shore. Habitat is usually inundated daily by tidal waters, with salinity moderated by freshwater inputs. Substrates are gravel, mud or occasionally peat. Introduced Ontario occurrences are in saline roadsides and disturbed ground.

Biology

Annual Saltmarsh Aster is a self-compatible annual that flowers from late July to early October. Size at maturity and number of florets and seeds produced varies substantially with ecological conditions. Seeds mature from late August to October, and disperse via tides and wind. Seed banking is likely significant as dense soil seed banks have been documented elsewhere. Seed germination and early seedling growth and survival may be suppressed by higher salinities.

Population Sizes and Trends

The Condons Pond subpopulation varied from 35,900 in 2013 to 1,000,000+ in 2014 when water levels were lower. Variations of that magnitude are not known elsewhere. The 18 native Canadian subpopulations total 445,000 to 1,410,000 plants depending on whether the higher or lower Condons Pond total is used. The five largest subpopulations (Condons Pond, Charlo River, Jacquet River, Cape Jourimain and Bass River) support between 91% and 97% of the Canadian population. Eight subpopulations are estimated at 1,000 to 8,150 plants each, and four have an estimated 200 to 600 plants each. Trends are poorly documented, but all sites ever documented in the native Canadian range are extant, and there is no indication of major habitat alteration that might have affected the total population size since the original status report in 1992.

Threats and Limiting Factors

Habitat alteration associated with residential development, transportation corridors and/or recreational activities associated with residences are potential or existing minor threats at most subpopulations. Bathurst Harbour and most Miramichi Bay subpopulations have extensive housing immediately adjacent to or near occupied habitat. This threat is low magnitude, however, as the species' habitats are fairly well protected through provincial wetland regulation. Sea level rise and severe weather, which could eliminate occupied habitat or increase estuary salinity beyond tolerated levels, may be significant future threats. Invasive exotic species are not a current threat although European Common Reed may become more significant in the future. A high rate of deer browsing was noted in one subpopulation in one year. Annual Saltmarsh Aster is adapted to natural disturbance and appears relatively resilient to observed human disturbances as long as nearby subpopulations and suitable substrate are maintained. Overall threat to the species in Canada is therefore fairly low. Natural limiting factors may include low probability of dispersal to available habitat, and the species' narrow niche requirements.

Protection, Status and Ranks

Canadian and New Brunswick legal status and protection currently apply only to subpopulations from Richibucto River, New Brunswick and north; *i.e*., the subpopulations with the characteristics of “Bathurst Aster”. Bathurst Aster is listed as Special Concern under Schedule 3 of Canada’s *Species at Risk Act*. In New Brunswick, Bathurst Aster is Endangered and its habitat is protected under prohibitions of the *New Brunswick Species at Risk Act*. Annual Saltmarsh Aster is Threatened in Maine, receiving protection under the *Natural Resource Protection Act* and the state’s *Site Law*, and it is protected as a Threatened species under New York’s *Environmental Conservation Law section 9-1503*. It is considered non-rare in most jurisdictions of occurrence, but is Critically Imperilled (S1) in Maine and Prince Edward Island, Imperilled (S2) in New York and New Brunswick and Vulnerable – Apparently Secure (S3S4) in North Carolina. It is currently unranked (SNR) in Quebec but will likely ultimately be ranked Critically Imperilled (S1).

TECHNICAL SUMMARY

Symphyotrichum subulatum

Annual Saltmarsh Aster

Aster subulé

Range of occurrence in Canada (province/territory/ocean): Quebec, New Brunswick, Prince Edward Island (Ontario is excluded as an extralimital introduction).

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines(2011) is being used)	One year (excluding any additional years as seeds in the seed bank)
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	No declines observed, inferred or projected
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	No declines observed, inferred or projected
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	No declines observed, estimated, inferred or suspected
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	No change projected or suspected
[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.	No declines observed, estimated, inferred or suspected
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	Not applicable a. b. c.
Are there extreme fluctuations in number of mature individuals?	Possibly. If two or more subpopulations were to fluctuate in the same direction, with the magnitude of variation seen at Condons Pond (35,900 to ~1,000,000 in one year), and without variation in the opposite direction elsewhere, the Canadian population of mature individuals could fluctuate by an order of magnitude, yet this fluctuation would be diminished when taking into account the seed bank.

Extent and Occupancy Information

Estimated extent of occurrence	16,260 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	148 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 – All occupied habitat patches are presumed large enough to support a viable population. b. Not clearly understood, though dispersal between subpopulations expected to be infrequent
Number of "locations"* (use plausible range to reflect uncertainty if appropriate)	Potentially as low as 11, or between 205 and 437 under different interpretations of threats (see **Number of Locations**)
Is there an [observed, inferred, or projected] decline in extent of occurrence?	No declines observed, inferred or projected
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	No declines observed, inferred or projected
Is there an [observed, inferred, or projected] decline in number of subpopulations?	No declines observed, inferred or projected
Is there an [observed, inferred, or projected] decline in number of "locations"*?	No declines observed, inferred or projected
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Potential for future minor decline in area and quality inferred, but major declines not projected
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	**N Mature Individuals**
1. Escuminac (QC)	2015 1,100 2016 26
2. Jacquet River (NB)	55,200
3. Charlo River (NB)	254,400
4. Beresford (NB)	500
5. Middle River / Little River (NB)	8,150
6. Tetagouche River (NB)	600
7. Nepisiguit River (NB)	2,100
8. Bass River (NB)	12,100
9. Teagues Brook (NB)	6,600
10. Bartibog River (NB)	200

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

11. Napan River (NB)	2,500
12. Black River (incl. Little Black River & Palmer Cove) (NB)	5,000
13. Bay du Vin River (NB)	7,000
14. Eel River (incl. Meadow Brook) (NB)	2,050
15. Portage River (NB)	2,100
16. Richibucto River (incl. Mill Creek & Childs Creek) (NB)	511
17. Cape Jourimain National Wildlife Area (NB)	50,000
18. Condons Pond (PE)	max. 2015 ~1,000,000 min. 2013 35,900
Total	**Max. 1,410,100** **Min. 445,000**
Counts are roughly estimated; see **Sampling Effort and Methods**	

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not completed

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

Was a threats calculator completed for this species? Yes (see Appendix 1). Participants: Mary Sabine, Ruben Boles, Jacques Labrecque, Jeannette Whitton, Jennifer Doubt, Bruce Bennett, and Sean Blaney.

i. Residential and commercial development
ii. Transportation and service corridors

What additional limiting factors are relevant?

- Naturally limited area of habitat with appropriately moderated salinity and climate
- Limited dispersal and establishment in unoccupied suitable habitat

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	U.S.A. – Secure (N5). Rare in Maine (S1; 450 km south), generally secure in coastal jurisdictions southward
Is immigration known or possible?	Not known. Possible via human-assisted movement along salted highways (not necessarily contributing to natural populations). Likely possible but infrequent via waterfowl.
Would immigrants be adapted to survive in Canada?	Probably yes, if from northern U.S.A.
Is there sufficient habitat for immigrants in Canada?	Yes, substantial apparently suitable but unoccupied habitat
Are conditions deteriorating in Canada?[+]	No, not believed to be substantially deteriorating

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

Are conditions for the source population deteriorating?[+]	No, not believed to be substantially deteriorating
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC: Designated Special Concern in April 1992. Status re-examined and designated Not at Risk in April 2017.

Status and Reasons for Designation:

Recommended Status: Not at Risk	**Alpha-numeric codes:** not applicable
Reasons for designation: This species typically occurs in brackish marsh and river shores. The species was previously assessed as Special Concern. Based on a revised taxonomy, it is now known to be more widely distributed in Canada, with subpopulations in Quebec, New Brunswick and Prince Edward Island. In addition, extensive targeted fieldwork has discovered numerous new occurrences. There is no current evidence of population decline or unnatural fluctuations and no significant threats appear to affect the species.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not met. There are no declines.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not met. While EOO is below threshold for Threatened and IAO is below the threshold for Endangered, there are >10 locations, no known decline, and no fluctuations.
Criterion C (Small and Declining Number of Mature Individuals): Not met.
Criterion D (Very Small or Restricted Population): Not met.
Criterion E (Quantitative Analysis): Not done.

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

PREFACE

COSEWIC assessed Bathurst Aster (*Aster subulatus* var. *obtusifolius*) in 1992 as Special Concern and this taxon was subsequently added to the *Species at Risk Act* on Schedule 3 as *Symphyotrichum subulatum*, Bathurst Population. Since 1992, multiple taxonomic evaluations have concluded that Bathurst Aster does not warrant recognition as a separate taxon and that it should be treated within the nominate variety of the species, now called *Symphyotrichum subulatum* var. *subulatum* (Annual Saltmarsh Aster). Therefore, this report follows the current taxonomic consensus and treats all Canadian occurrences of Annual Saltmarsh Aster as *Symphyotrichum subulatum* var. *subulatum*, including occurrences in southeastern New Brunswick at Cape Jourimain and in eastern Prince Edward Island at Condons Pond that tend not to exhibit the characteristics (small size, blunt leaves, fleshier texture) of Bathurst Aster and, if Bathurst Aster were still recognized taxonomically, would be classified as the nominate variety *subulatum* in the strict sense.

The 1992 assessment examined a taxon believed to be extremely rare globally, with its world distribution restricted to the mouths of two rivers 5 km apart in Bathurst Harbour, New Brunswick. The known distribution of the Annual Saltmarsh Aster has greatly increased since the 1992 status assessment of “Bathurst Aster”. It is now known from 18 subpopulations extending from the Escuminac River on the south shore of Quebec’s Gaspé Peninsula south 210 km to the Richibucto River estuary. The inclusion of the typical (non-“Bathurst” morphotype) Annual Saltmarsh Aster subpopulations at Cape Jourimain, New Brunswick, and Condons Pond, Prince Edward Island in this assessment extends the range a further 195 km southeast. This has produced major increases in extent of occurrence (from about 1.4 km^2 to 16,260 km^2) and index area of occupancy (from 8 km^2 to 148 km^2). The known population has increased from “several thousand” to between 445,000 and 1.41 million. Major imminent threats are not known at any sites, and the much larger and more widespread nature of the Canadian population compared to the situation described in 1992 means that the overall threat level is now understood to be much lower.

The discovery of numerous new occurrences was largely a result of extensive targeted fieldwork searching for the species and for other associated rare species of brackish tidal shores. This fieldwork, mostly by Atlantic Canada Conservation Data Centre, Irving Eco-Centre in Bouctouche, New Brunswick, New Brunswick Department of Natural Resources staff, Rosemary Curley and Frédéric Coursol, has covered potential habitat within the currently known range fairly well (see **Search Effort**) so although some additional new occurrences are still likely be discovered, the majority of Canadian occurrences may now be documented.

In Canada, Annual Saltmarsh Aster is also known from non-native occurrences in highway ditches and other anthropogenic saline habitats in southwestern Ontario. These exotic and extralimital occurrences are considered ineligible for assessment and thus are not evaluated in this report.

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
(2017)

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:	*Symphyotrichum subulatum* (Michx.) G.L. Nesom
Synonyms:	*Aster subulatus* Michx. *Aster subulatus* var. *subulatus* *Aster subulatus* Michx. var. *obtusifolius* Fernald *Aster subulatus* Michx. var. *euroauster* Fernald & Griscom Only northeastern North American synonyms are listed here; see Tropicos (2016) for a full synonymy
Common Names: English:	Eastern Annual Saltmarsh Aster Annual Saltmarsh American-aster Bathurst Aster Saltmarsh Aster Small Saltmarsh Aster Expressway Aster
French:	Aster subulé
Family:	Asteraceae
Order:	Asterales
Superorder:	Asteranae
Class:	Magnoliopsida
Subdivision:	Spermatophytina
Division:	Tracheophyta

Annual Saltmarsh Aster was described by Michaux (1803) as *Aster subulatus* and the taxon has consistently been recognized at the species level since that time. The species' broad geographic range and highly variable morphology resulted in an extensive proliferation of taxa now considered synonyms (53 listed in Tropicos 2016). The five currently recognized North American varieties of *Symphyotrichum subulatum* (Sundberg 2004; Brouillet *et al.* 2006) are partly reproductively isolated by chromosome number differences (Sundberg 1986, 2004) and all were treated as species by Nesom (1994, 2005). In addition to variety *subulatum* (2n = 10), other varieties include: variety *parviflorum* (= *Symphyotrichum expansum*, 2n = 10), variety *elongatum* (=*S. bahamense*; 2n = 20), variety *squamatum* (=*S. squamatum*; 2n = 20) and variety *ligulatum* (=*S. divaricatum*; 2n = 10) (chromosome numbers from Nesom 2004), all of which occur no closer to Canada than North Carolina (Brouillet *et al.* 2006).

The species was first collected in the Canadian Maritimes by Harvard University botanists Merritt L. Fernald and Emile F. Williams in 1902 from Bathurst Harbour in New Brunswick. Fernald (1914) noted some differentiating characters in those collections that "if constant, would indicate a clearly marked species, but a close study of the available material shows that they are not absolute." Fernald (1914) thus named the taxon at the varietal level, *Aster subulatus* var. *obtusifolius* (referring to its more spatulate, obtuse leaves), noting that the variety's characters overlapped with *Aster subulatus* from elsewhere in its distribution, especially from New England. Sundberg (1986) evaluated rangewide variation in the species complex that includes Annual Saltmarsh Aster and concluded that var. *obtusifolius* should not be recognized, synonymizing it with *Aster subulatus* var. *subulatus*.

In the original COSEWIC status report, Hinds and Flanders (1992) rejected the Sundberg (1986) synonymy of variety *obtusifolius* under *Aster subulatus* var. *subulatus*, noting morphological and ecological discontinuities between the two varieties and citing their own unpublished information (no longer available) from common garden experiments on New Brunswick plants (Hinds 1989).

In the 1990s and early 2000s, analyses of morphology, chloroplast DNA, and karyotypes demonstrated the broadly defined genus *Aster* to be polyphyletic and divided it into multiple genera (Nesom 1994; Semple *et al.*1996; Noyes and Rieseberg 1999; Brouillet *et al.* 2001a,b). Nesom (1994) proposed that *Aster subulatus* be treated as *Symphyotrichum subulatum* under the new generic taxonomy and that *Aster subulatus* var. *obtusifolius* be treated as a synonym of *Symphyotrichum subulatum* var. *subulatum*, following Sundberg (1986). Semple *et al.* (2002), Nesom (2004), Kartesz (1999, 2015), and the Flora of North America (Brouillet *et al.* 2006) have all included var. *obtusifolius* under *Symphyotrichum subulatum* var. *subulatum* or under *S. subulatum* with other varieties treated at the species level.

Hughes (2015) conducted a greenhouse study of *Symphyotrichum subulatum* var. *subulatum* plants from ten sites in seven New Brunswick subpopulations, one Prince Edward Island subpopulation and one New Jersey subpopulation specifically to investigate the potential distinctness of variety *obtusifolius.* He found some statistically significant phenotypic differences between subpopulations, and some geographic pattern to that variation, with a stronger tendency for dwarf, early-maturing plants in the northern part of the Canadian range. However, he noted extensive overlap in characteristics between "Bathurst Aster" (variety *obtusifolius*) and typical Annual Saltmarsh Aster, stating that his evidence was insufficient to warrant recognizing variety *obtusifolius* as a separate taxon.

This report follows the recent taxonomic consensus described above in treating all Canadian occurrences of Annual Saltmarsh Aster as *Symphyotrichum subulatum* var. *subulatum*, and because this is the only variety in Canada the report treats the taxon as *Symphyotrichum subulatum*.

Morphological Description

Annual Saltmarsh Aster is a halophytic (salt-loving) annual. Although the species can reach 150 cm in the southern parts of its range (Brouillet *et al.* 2006), plants in the native Canadian population are more typically 2 to 30 cm at maturity, and frequently less than 10 cm high (AC CDC botanists pers. obs. 1999-2015), even when grown under greenhouse conditions (Hughes 2015). The stem is smooth, somewhat fleshy, and often branches from the base. The leaves are 10 to 90 mm long, 6 to 14 mm wide, and usually have smooth margins, The leaf shape varies from narrowly lanceolate with pointed tips (more typical in the United States; Gleason 1963) to spatulate or oblanceolate with rounded tips (more typical in Atlantic Canada, especially northward; Hinds and Flanders 1992; Hughes 2015). The lower leaves often wither by flowering time. Individual plants in the Maritimes typically produce 5-60 heads in an elongate, pyramidal, inflorescence that can be much-branched in larger plants. Involucres are 6 to 7 mm long, with 18 to 30 phyllaries (overlapping bracts that form a cup around the floret bases) that are subulate to lanceolate, narrow, and with green zones that are narrowly to broadly lanceolate and extend the full phyllary length. Ray florets are white with a barely perceptible tinge of blue, ranging from 1.5 to 2.6 mm long, and typically numbering 16 to 30 per involucre. Disc florets are yellow and number 4 to 10 per involucre. Figure 1 illustrates the plant.

The nominate variety *subulatum* is distinguished from the four other varieties, none of which occur north of North Carolina, by its whitish ray blades of 1.3 to 3.0 mm in length (shorter to slightly longer than pappi), and by the 18 to 30 phyllaries with narrowly to broadly lanceolate green zones extending over their full length (Brouillet *et al.* 2006).

The Annual Saltmarsh Aster's short (<10 mm) ray florets easily distinguish it, when in flower, from the two other saltmarsh asters of its Canadian range, the abundant New York Aster (*Symphyotrichum novi-belgii*), which has longer ray florets, and the rare Gulf of St. Lawrence Aster (*Symphyotrichum laurentianum*), which lacks ray florets.

Figure 1. Annual Saltmarsh Aster (*Symphyotrichum subulatum*) representative of the “Bathurst Aster” form (large and small individuals, top, from Escuminac River, Quebec on left, and Teagues Brook, New Brunswick on right) and representative of the nominate (non-Bathurst) form with taller stature, more flower heads, more pointed and less fleshy leaves, from Condons Pond, Prince Edward Island (bottom). Photos, clockwise, by David Mazerolle, Alain Belliveau, Karen Samis and Sean Blaney.

Population Spatial Structure and Variability

Annual Saltmarsh Aster (variety *subulatum*) occurs fairly continuously along the Atlantic coast from southern Maine to central Florida and along the Gulf of Mexico coast from central Florida to east Texas (Kartesz 2015), with a gap in distribution around southern Florida where varieties *elongatum* and *ligulatum* occur. Distribution is more patchy inland in the southern United States, reflecting both recent adventive colonization events and rare native occurrences in natural saline sites as is believed to be the case in highly disjunct occurrences in Nebraska (900 km disjunct from nearest native occurrence), Arkansas, and upstate New York (each about 300 km disjunct from nearest native occurrences; Kartesz 2015). The Canadian population is disjunct from the nearest occurrence in Sagadahoc County, Maine (GoBotany 2016) by 450 km.

Subpopulations are defined in this report using habitat-based plant element occurrence delimitation standards (NatureServe 2004), under which occurrences are lumped into a single subpopulation if separated by less than 1 km, or if separated by 1 to 3 km with no break in suitable habitat between them exceeding 1 km, or if separated by 3 to 10 km but connected by linear water flow and having no break in suitable habitat between them exceeding 3 km. Application of the linear water flow and unsuitable habitat criteria are somewhat subjective, but this report divides occurrences into 18 subpopulations, one in Quebec, 16 in New Brunswick and one in Prince Edward Island (Table 1).

Table 1. Canadian native subpopulations of Annual Saltmarsh Aster (AC CDC 2016), rounded to nearest hundred where 100+. "# Rec." = Number of records upon which count was based. See Sampling Effort and Methods for description of limitations of the counts. "Count Date" is the year in which data for the count was compiled. Subpopulations are mapped in Figure 3. If defining locations based on barrier dune / estuary systems, locations correspond to "Estuary #".

Sub pop.	Prov	Subpopulation Name	Site Name	Estuary #	# Rec.	# Plants	First Obs.	Last Obs.	Count Date
1	QC	Escuminac River		[no barrier dune]	24	(2015) 1,100 (2016) 26	2015	2016	2015
2	NB	Jacquet River		1	2	55,200	2013	2013	2013
3	NB	Charlo River		2	63	254,400	2013	2013	2013
4	NB	Beresford		3	14	500	2013	2013	2013
5	NB	Middle River / Little River		4 Bathurst Harbour	46	8,150	1902	2015	2015
6	NB	Tetagouche River		4 Bathurst Harbour	9	600	1913	2013	2013
7	NB	Nepisiguit River		4 Bathurst Harbour	5	2,100	1902	2015	2015
8	NB	Bass River		5	26	12,100	1995	2015	2015
9	NB	Teagues Brook		6	10	6,600	1995	2015	2015
10	NB	Bartibog River		7 Miramichi Bay	4	200	2003	2013	2003
11	NB	Napan River		7 Miramichi Bay	52	2,500	2003	2015	2015

Sub pop.	Prov	Subpopulation Name	Site Name	Estuary #	# Rec.	# Plants	First Obs.	Last Obs.	Count Date
12	NB	Black River	Black River	7 Miramichi Bay	13	4,000	2003	2015	2003
12	NB	Black River	Little Black River	7 Miramichi Bay	18	800	2003	2013	2013
12	NB	Black River	Palmer Cove	7 Miramichi Bay	6	200	2015	2015	2015
13	NB	Bay du Vin		7 Miramichi Bay	58	7,000	2003	2015	2015
14	NB	Eel River	Eel River	7 Miramichi Bay	13	400	2013	2013	2013
14	NB	Eel River	Meadow Brook	7 Miramichi Bay	13	1,650	2015	2015	2015
15	NB	Portage River		7 Miramichi Bay	12	2,100	2015	2015	2015
16	NB	Richibucto River	Mill Creek	8 Richibucto R.	13	500	2007	2013	2013
16	NB	Richibucto River	Childs Creek	8 Richibucto R.	2	11	2013	2013	2013
17	NB	Cape Jourimain NWA		9	1	50,000	1992	2013	2004
18	PE	Condons Pond		10	1	(2013) 35,900 (2014) 1,000,000	2003	2014	2013-2014
TOTAL					**405**	**(min.) 445,000 (max.) 1,140,100**			

Within the native Canadian range, distribution is largely associated with river mouths and is thus discontinuous along the coast. Bathurst Harbour (three subpopulations), Miramichi Bay (six subpopulations in nine sites), and Richibucto River (one subpopulation with two sites) may all be metapopulations in which some potential for dispersal between subpopulations or sites is possible (see **Dispersal and Migration**). Straight-line distances between the more northern subpopulations (all of which exhibit characteristics of “Bathurst Aster”) range from 4 km between Black River (Little Black River site) and Bay du Vin River to 42 km between Richibucto River and Eel River. The two “non-Bathurst” subpopulations at Cape Jourimain, New Brunswick (96 km east of Richibucto River) and Condons Pond, Prince Edward Island (105 km east of Cape Jourimain) are the most isolated.

Sundberg (2004) notes that the varieties of Annual Saltmarsh Aster are probably mostly genetically isolated from one another by differences in chromosome counts, and that all varieties except *ligulatum* are self-compatible. This could facilitate fixation of mutations, especially in disjunct occurrences subject to founder effects, although self-compatibility doesn’t necessarily indicate limited outcrossing. Nesom (2004) notes that the varieties maintain their distinctive morphology in regions such as Japan where multiple varieties have been introduced. There has been no specific investigation of genetic diversity in Annual Saltmarsh Aster in Canada or elsewhere, though patterns of morphological variation suggest the possibility of some genetic differentiation of the Canadian population from that in the United States, starting with Fernald’s (1914) recognition of the population as the endemic variety *obtusifolius.* Fernald noted that the observed differences in Canadian plants overlap with those found elsewhere, especially in New England. Hughes (2015) found that under common conditions plant height tended to decrease with latitude of subpopulation origin in a general south to north trend, but found dwarfed plants in each subpopulation examined. The Hughes (2015) common garden study noted that differences

between subpopulations in height, branching and time to maturity were less substantial and less spatially patterned in the F_2 generation (seeds from plants grown in common conditions) compared to differences found in the F_1 generation (seeds from wild plants), which suggests that much of the initial variation observed may have been a result of parental effects and plasticity rather than genetic differences.

Designatable Units

Annual Saltmarsh Aster occurs in two of COSEWIC's National Ecological Areas (COSEWIC 2015). The Quebec, New Brunswick, and Prince Edward Island subpopulations are within the Atlantic National Ecological Area and the Ontario subpopulations are within the Great Lakes Plains National Ecological Area. Ontario subpopulations are considered exotic and extralimital (see **Canadian Range**) and therefore ineligible for status assessment (COSEWIC 2010, 2015).

Although there is some patterned morphological variation within the native Canadian population (see **Population Spatial Structure and Variability**) and there was previous taxonomic recognition of a portion of that population (all subpopulations except for Cape Jourimain and Condons Pond) as the endemic variety *obtusifolius*, current taxonomic consensus and recent directed research (Hughes 2015) does not support recognition of that variety (see **Name and Classification**). Thus, all subpopulations within the Atlantic National Ecological Area are considered a single designatable unit in this report.

Special Significance

The native Canadian population represents the northernmost subpopulation of Annual Saltmarsh Aster in its native range and is 450 km disjunct from the next nearest subpopulations in southern Maine. Most occurrences exhibit characteristics somewhat distinct from the American plants, and were previously recognized as the endemic Bathurst Aster, suggesting the possibility of some degree of genetic distinction. Populations at the edge of a species' geographical range often occupy less favourable habitats, exhibit lower densities, tend to be more fragmented, and are less likely to receive immigrants from other populations (Channel and Lomolino 2000). Through isolation, genetic drift and natural selection, peripheral populations may give rise to genetic, ecological and morphological divergence, increasing their conservation significance as sources of adaptive genotypes and as source populations for range recolonization or migration (Lesica and Allendorf 1995; Garcia-Ramos and Kirkpatrick 1997; Gibson *et al.* 2009).

Annual Saltmarsh Aster may act as a sentinel species (Beeby 2001) for the brackish habitats in which it occurs. These habitats are often within or near provincially significant wetlands that are specially managed under provincial policies and regulations (NB DNRE / DELG 2002) and the presence of this species may help wetland managers with the identification of particularly sensitive wetland habitat. It is also a member of a distinct suite of southern coastal species having disjunct populations along the relatively warm Gulf of St. Lawrence coast, including globally rare Parker's Pipewort (*Eriocaulon parkeri*), federally listed Beach Pinweed (*Lechea maritima*, COSEWIC and SARA Special Concern) and

Eastern Lilaeopsis (*Lilaeopsis chinensis*, COSEWIC and SARA Special Concern), and nationally rare Spongy Arrowhead (*Sagittaria montevidensis* ssp. *spongiosa*; Threatened in Quebec).

Information on the chemical constituents of the species has been published in at least four studies prospecting for compounds with medicinal properties. Chemicals extracted from Annual Saltmarsh Aster have been reported to have antioxidative activity (El-Sayed *et al.* 1987; Ko *et al.* 2009), anti-ulcer activity (Ghedini *et al*. 2007), and anti-inflammatory value (Lee *et al*. 2012). The Annual Saltmarsh Aster variety *squamatum* is used in southern Brazil in folk medicine as an antidiarrhoeic (Almeida *et al*. 1995).

DISTRIBUTION

Global Range

Annual Saltmarsh Aster in the broad sense (including all five varieties noted under **Name and Classification**) is a very widespread species, occurring along the eastern North American coastline from southeastern Quebec south to Mexico, and also occurring in the West Indies, Bermuda, Central America, and eastern and western South America south to at least northern Argentina (Brouillet *et al.* 2006; Vignolio and Fernandez 2011; Wiersema and León 2013). The species has also been documented from inland localities in the southwestern United States from Oklahoma and Texas to Nevada and California. The Canadian population consists of only the nominate variety *subulatum*. Outside Canada, this variety occurs only in the eastern United States from southeastern Quebec to Texas along the Atlantic Coast and at inland localities in Alabama, Mississippi, Arkansas and Texas (Figure 2). Inland records include both adventive occurrences on roadsides or other artificially salinified habitats, and presumed native occurrences at isolated naturally saline wetlands (Nesom 2004; Brouillet *et al.* 2006; Kartesz 2015).

Annual Saltmarsh Aster is also widely introduced worldwide. Variety *subulatum* is introduced in Asia and Africa (Brouillet *et al.* 2006). Variety *squamatum*, from South America and Bermuda, is introduced in California, Texas, Louisiana, Alabama, Florida, Georgia, and North Carolina as well as Europe, east and west Asia, Africa, Australia, and New Zealand (Brouillet *et al.* 2006; Wiersema and León 2013; Jepson Herbarium 2016). Variety *parviflorum* is introduced in Japan and Hawaii (Brouillet *et al.* 2006), and variety *elongatum* is introduced in California (Brouillet *et al.* 2006). In North America, introduced occurrences of variety *subulatum* are known from the southern end of Lake Michigan in Illinois [where the species is known as “Expressway Aster” because of its association with saline highway ditches (Illinois Wildflowers 2016)] and Indiana, and in southeastern Michigan, northern Ohio and southern Ontario between Windsor and Toronto (Kartesz 2015; Oldham pers. comm. 2016).

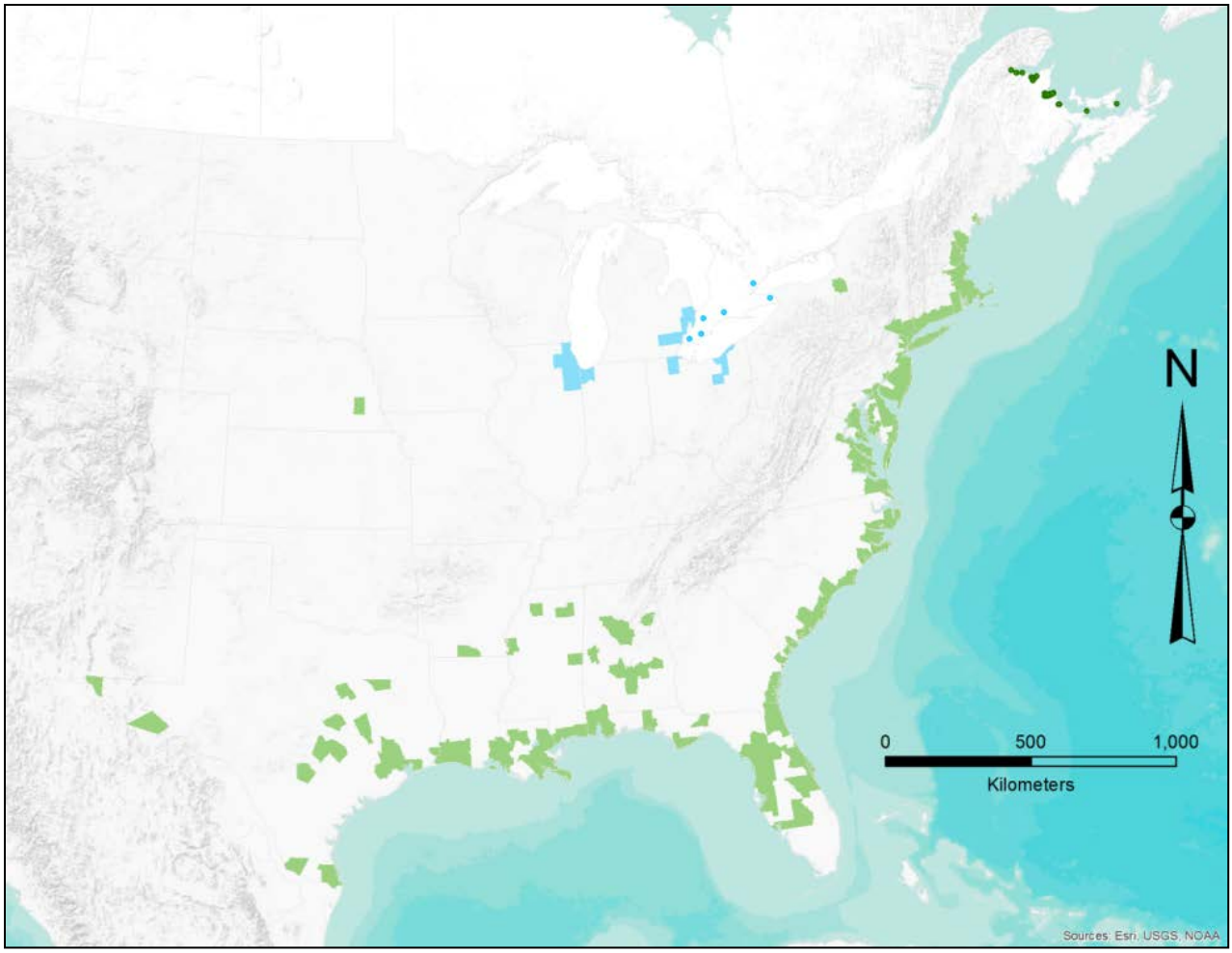

Figure 2. Range of typical Annual Saltmarsh Aster (*Symphyotrichum subulatum* var. *subulatum*) in eastern North America, modified from Kartesz (2015). In the United States, a whole county is shaded if a record is known, with green counties representing native or potentially native occurrences and blue counties representing non-native occurrences. Canadian occurrences are represented by green dots (native occurrences from AC CDC 2016) and blue dots (introduced occurrences from Oldham pers. comm. 2016).

Canadian Range

Annual Saltmarsh Aster's native Canadian range is restricted to the Atlantic National Ecological Area, along the Atlantic coast from southeastern Quebec to southeastern Prince Edward Island, spanning a straight-line distance of approximately 380 km representing approximately 600 km of coastline (Figure 3; AC CDC 2016). The northernmost occurrence of the species is also the only known occurrence in Quebec, at latitude 48 °N along the Escuminac River and inner Chaleur Bay (Avignon Regional County Municipality). In New Brunswick, it occurs on Chaleur Bay (Restigouche County), Nepisiguit Bay (Gloucester County), and along the province's eastern shore in Miramichi Bay (Northumberland County), in the Richibucto River estuary (Kent County), and at Cape Jourimain (Westmorland County). In Prince Edward Island, it is known only from one subpopulation, at Condons Pond (Kings County), near the island's southeastern tip. The largest gap

between known occurrences in the Maritimes is between Cape Jourimain, New Brunswick and Condons Pond, Prince Edward Island, approximately 105 km straight line distance (AC CDC 2016). The Canadian population is separated from the nearest non-Canadian population in Maine by 450 km.

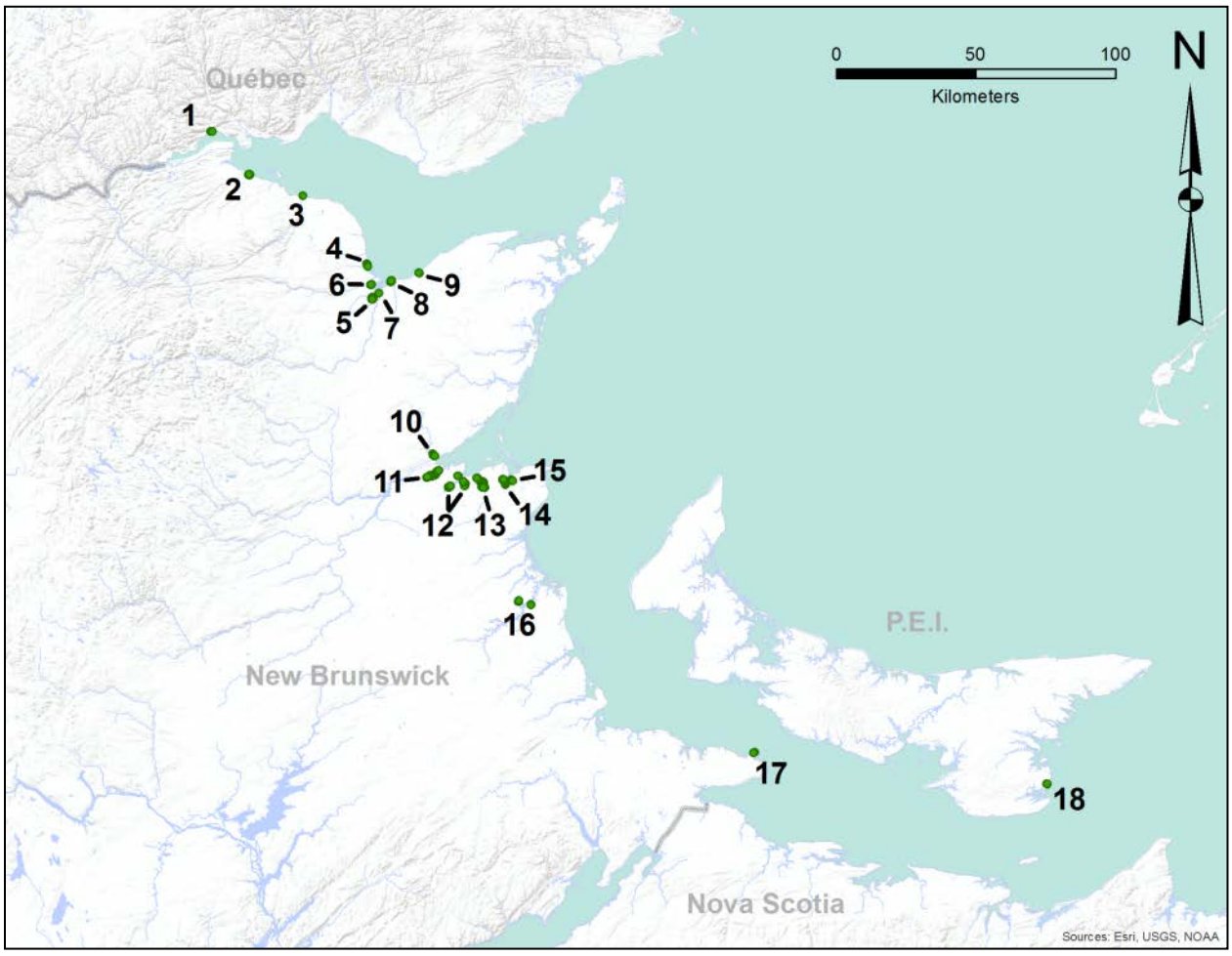

Figure 3. Canadian native range of Annual Saltmarsh Aster (*Symphyotrichum subulatum*) from AC CDC (2016). Subpopulation numbers are: 1) Escuminac River, 2) Jacquet River, 3) Charlo River, 4) Beresford, 5) Middle River / Little River, 6) Tetagouche, 7) Nepisiguit, 8) Bass River, 9) Teagues Brook, 10) Bartibog River, 11) Napan River, 12) Black River (including Little Black River and Palmer Cove), 13) Bay du Vin, 14) Eel River (including Meadow Brook), 15) Portage River, 16) Richibucto River (including Mill Creek and Childs Creek), 17) Cape Jourimain National Wildlife Area, 18) Condons Pond.

Annual Saltmarsh Aster has been recorded in Ontario between Toronto and Windsor at least 16 times since 1981, all from anthropogenically disturbed sites, most of which showed some indication of salinity (Oldham pers. comm. 2016; Reznicek pers. comm. 2016). The Ontario occurrences of Annual Saltmarsh Aster are considered non-native and extralimital because: a) most occurrences in the Great Lakes region are considered non-native by authoritative sources (Brouillet *et al.* 2006; NatureServe 2016), except for one presumed native occurrence at a naturally saline spring in Onondaga County, New York

(Young 2010); b) all are restricted to highly disturbed localities; c) the species was not reported in the Detroit area of Michigan until 1914 (Voss 1996) and not in Ontario until 1980 (Catling and McKay 1980), well after most native species in the region had been documented; and d) because natural salt springs likely never occurred in the Windsor region due to the depth of salt deposits, meaning that halophytes like Annual Saltmarsh Aster would be unlikely to occur naturally (Hewitt 1962; Catling and McKay 1980,1981).

On a coarse scale (1:30,000,000) of the approximately 4,000 km (estimated with Measure tool in ArcMap 10.3.1) of coast with known, county-level distribution of the variety *subulatum* (Kartesz 2015) in North America, approximately 3.8% (150 km of coarsely depicted coast) is in Canada.

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO) for native Annual Saltmarsh Aster in Canada is 16,260 km^2 (AC CDC 2016; calculated using the Convex Hull Minimum Bounding Geometry tool in ArcMap 10.3.1). The calculated extent of occurrence for the native Canadian population includes a considerable area of unsuitable marine and interior habitat.

Index of area of occupancy (IAO) is 148 km^2 based on documented occurrence in 37 2 km x 2 km squares (AC CDC 2016) aligned with the Universal Transverse Mercator (UTM) 10 km x 10 km grid depicted on National Topographic System maps (Natural Resources Canada 2016).

Search Effort

Merritt L. Fernald and Emile F. Williams first noted Maritimes occurrence of Annual Saltmarsh Aster "...at mouth of Nepisiguit (possibly Middle)[1] River, Bathurst" in 1902 in Bathurst Harbour, New Brunswick, during a general botanical exploration of the southwestern Gulf of St. Lawrence coast (Fernald 1914). Botanical fieldwork prior to 1986 in potential habitat in the Maritimes was limited and not specifically directed at finding Annual Saltmarsh Aster. In 1986 *Flora of New Brunswick* author Harold R. Hinds targeted the species, rediscovering the Tetagouche River and Middle River occurrences in Bathurst Harbour and finding an occurrence of the nominate (non-Bathurst) variety at Cape Jourimain 220 km southeast. From 1986 to 2002 various targeted searches and revisitation of known sites were conducted in the vicinity of Bathurst Harbour, documenting additional sites at Bass River and Teagues Brook just east of Bathurst Harbour (Hoyt 2003).

There has been extensive fieldwork targeting potential Annual Saltmarsh Aster habitat since 2002 (Figure 4). In 2005, fieldwork by AC CDC and Frédéric Coursol in association with a COSEWIC status report on Parker's Pipewort visited 33 sites on brackish tidal rivers and found five Miramichi Bay subpopulations (Bartibog River, Bay du Vin River, Black River,

[1] The quote from Fernald's 1902 specimen label is taken out of Hinds and Flanders (1992). Because the bracketed mention of Middle River was included in quotes by Hinds and Flanders (1992), one would assume that Fernald was uncertain of the location, but it is possible that Hinds inserted the bracketed notation. Elsewhere in the report Hinds suggests the record was most likely from Middle River, which makes sense given Blake's 1913 collection from Middle River and the abundance of the aster there to the present, with sparser occurrence at the Nepisiguit River mouth (AC CDC 2016).

Little Black River, and Napan River; Blaney 2005; Coursol data in AC CDC 2016). In 2005 and 2007, Bouctouche Dune Irving Eco-Centre staff visited similar habitats at 20 sites on New Brunswick's coast south of Miramichi Bay documenting a single record on the Richibucto River estuary at Mill Creek (data in AC CDC 2016). AC CDC fieldwork in 2012 and 2013 visited 31 sites (including five with previously known occurrences) from the Quebec – New Brunswick border to the Richibucto River and found four new subpopulations (Charlo River, Jacquet River, Beresford and Eel River) and new occurrences within the Black River and Richibucto River subpopulations (Mazerolle and Blaney 2013, 2014). Fieldwork for this status report in 2015 included visits to 26 sites in Quebec and New Brunswick (seven of which were previously known), documenting the first provincial record for Quebec, three new sites within Miramichi Bay subpopulations, and delineating extent on three Miramichi Bay subpopulations where the species was already known (Blaney *et al.* 2015).

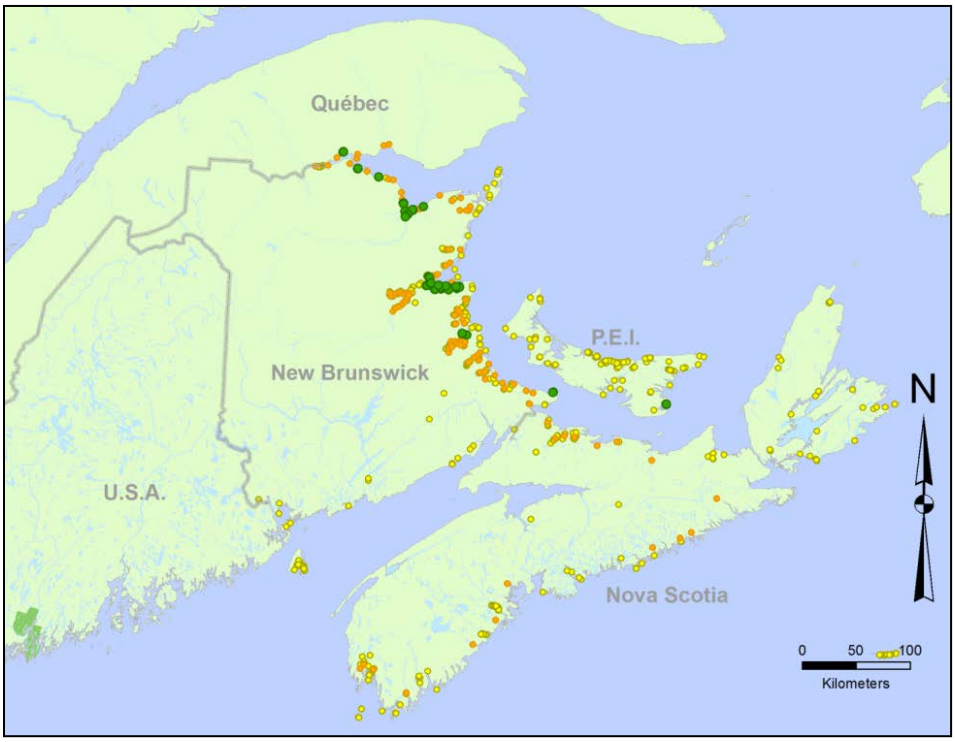

Figure 4. Survey effort for Annual Saltmarsh Aster. Green dots are known occurrences from AC CDC (2016). Orange dots are localities of survey efforts specifically focused on Annual Saltmarsh Aster and other rare plants of brackish tidal habitat, mostly by AC CDC. Yellow dots are additional localities of brackish tidal specialist species[2], indicating some botanist attention with potential to have detected Annual Saltmarsh Aster (though not generally indicating comprehensive survey). The green shaded area in the bottom left marks Sagadahoc County, Maine, site of the nearest American occurrence.

[2] Brackish tidal specialist species are: Eaton's Beggarticks (*Bidens eatonii*), Estuary Beggarticks (*Bidens hyperborea*), Estuary Sedge (*Carex recta*), Estuarine Sedge (*Carex vacillans*), Water Pygmyweed (*Crassula aquatica*), Shining Flatsedge (*Cyperus bipartitus*), Parker's Pipewort (*Eriocaulon parkeri*), Eastern Lilaeopsis (*Lilaeopsis chinensis*), Water Mudwort (*Limosella aquatica*), Southern Mudwort (*Limosella australis*), Long-lobed Arrowhead (*Sagittaria calycina* var. *spongiosa*), Seaside Brookweed (*Samolus valerandi* ssp. *parviflorus*), Smith's Bulrush (*Schoenoplectus smithii*), Indian Wild Rice (Zizania *aquatica* var. *brevis*), and Dwarf Spikerush (*Eleocharis parvula*).

Figure 5. Annual Saltmarsh Aster habitat on sparsely vegetated alluvial gravel at the mouth of the Charlo River, New Brunswick, the largest Canadian subpopulation (top). Much of the vegetation in the foreground is small individuals of the species. The bottom photo is more densely vegetated saltmarsh habitat occupied by the aster at Jacquet River, New Brunswick. Photographs by David Mazerolle, AC CDC.

Outside New Brunswick, Rosemary Curley and AC CDC have visited a significant proportion of brackish ponds on Prince Edward Island, with just one occurrence found at Condons Pond (AC CDC 2016). Significant efforts have also been made by AC CDC to cover potential habitat in mainland Nova Scotia, with brackish tidal zones of 18 high potential rivers visited in surveys targeting the species and other rare plants of the same habitat (Blaney and Boates 2004, 2005; Blaney *et al.* 2010). Occurrence in Quebec has not yet been thoroughly studied but is unlikely to be widespread, given that suitable rivers are limited in number and the most promising rivers have already been searched. It also seems likely that Annual Saltmarsh Aster might be climatically limited to the relatively warm Chaleur Bay (translation: heat bay) region in Quebec given that the aster is a generally southern species at its northern limit and is absent from the comparatively cool waters of the Bay of Fundy further south in southern New Brunswick and eastern coastal Maine.

The extensive increase in known range within Canada since 2000 is believed to be a result of increased field effort and not reflective of range expansion. There is still potential for discovery of additional occurrences in Quebec, New Brunswick, Prince Edward Island, and Nova Scotia (where the species is not yet known), but in New Brunswick much of the highest potential habitat has been visited by botanists and it seems likely that a majority of native subpopulations have been documented. Finer scale distribution and abundance within some subpopulations would likely be expanded somewhat with further field survey because some suitable habitat patches have not yet been surveyed, and it may have been overlooked at some sites because the species can be hard to find at low densities and local distribution and abundance probably varies somewhat year to year. The potential for further fieldwork to extend local distribution is high along the southern shore of the Miramichi Bay estuary, especially along the Black River between known sites and on sites downstream on the Little Black River and Palmer Cove.

HABITAT

Habitat Requirements

Annual Saltmarsh Aster occurs in tidally influenced saline marshes and brackish river shores, mostly in gravel and muddy substrate and occasionally on peaty organic substrate (Brouillet *et al*. 2006; New York Natural Heritage Program 2015; AC CDC 2016; GoBotany 2016; Figure 1). Further south, it has been reported that slight differences in water depth, soil moisture, and soil salinity can significantly influence its presence, seed density, and seedling emergence (Elsey-Quirk *et al*. 2009a,b). At most Canadian sites, plants are subject to daily inundation by brackish tidal water and are often found in areas with especially limited competition from other species. When plants occur within denser saltmarsh vegetation, they typically occur in much lower densities (AC CDC botanists pers. obs. 1999-2015). The aster is generally restricted to continually moist habitat, and can occur in fine or medium grained mineral or organic soil. The species can tolerate low fertility soil and a range of pH from 5.59 to 7 (USDA NRCS 2016). Limited specific information is available for the preferred average soil salinity, inundation period, or soil aeration, but observations by the AC CDC (2016) suggest the species' native Canadian occurrences are

limited to fairly specific tidal conditions with strong moderation of salinity via freshwater inputs of streams or rivers. It appears to be most abundant in shorelines submerged by the tide for at least part of the tidal cycle (AC CDC pers. obs. 1999-2015). Elsey-Quirk *et al*. (2009a) found Annual Saltmarsh Aster to have the greatest dependency on an open canopy (lack of competition) for establishment among a suite of saltmarsh species investigated in Louisiana, noting increased seedling density on bare soil and in areas with competing plants experimentally clipped.

Frequently associated species on the open patches of gravel and mud include Three-square Bulrush (*Schoenoplectus pungens*), Saltmarsh Sand-Spurry (*Spergularia salina*), Canada Sand-Spurry (*Spergularia canadensis)*, Egede's Silverweed (*Argentina egedii*), Thick-leaved Orache (*Atriplex subspicata*) and Seaside Arrowgrass (*Triglochin maritima*), and Seaside Plantain (*Plantago maritima*) (Hinds and Flanders 1992; AC CDC botanists pers. obs. 1999-2015; Hoyt 2003). In the more densely vegetated saltmarsh margins associated species include: Hardstem Bulrush (*Schoenoplectus acutus*), Redtop Bentgrass (*Agrostis stolonifera*), Seaside Milkwort (*Glaux maritima*), Egede's Silverweed, Saltmeadow Cordgrass (*Spartina patens*), Smooth Cordgrass (*Spartina alterniflora*), and Three-square Bulrush (Hinds and Flanders 1992; Hoyt 2003; AC CDC 2016).

Outside its native Canadian range, Annual Saltmarsh Aster occurs locally in non-coastal habitats, including inland saltmarsh (Faust and Roberts 1983), along salted highways, and around salt mines and other anthropogenically disturbed, salted habitats (Reznicek 1980; Catling and McKay 1981; Kral *et al.* 2016; Oldham, pers. comm. 2016). In the absence of competition it grows well in non-saline soil (Hinds and Flanders 1992; Hughes 2015), and it occurs in some non-saline inland areas, primarily in the southern United States (Zomlefer and Giannasi 2005; Barger *et al.* 2014; Kral *et al.* 2016), but also locally in Ontario where Reznicek (pers. comm. 2016) reports Annual Saltmarsh Aster occurrence in non-saline, low competition sites near large roadside occurrences because of the abundance of wind-dispersed seeds.

Habitat Trends

Annual Saltmarsh Aster occurrences in Atlantic Canada do not show evidence of major recent change (AC CDC botanists pers. obs. 2016). Fieldwork in 2013 and 2015 found the species in all 12 subpopulations where it had previously been recorded. All subpopulations are in areas having had long-term European settlement and most have extensive anthropogenic impacts nearby including housing, cottages, farms, roads, bridges, causeways, public parks, and boat launches (AC CDC botanists pers. obs. 1999-2015; Google Earth 2016). Annual Saltmarsh Aster seems to be generally able to persist in habitats in which lawns, roadways, agricultural fields and other developments extend right to the tidal zone, as long as the saltmarsh and gravel or mud shores remain (AC CDC botanists pers. obs. 2016). Human impacts have reduced the extent of saltmarsh habitat in New Brunswick since European settlement (Roberts 1993; NB DNRE / DELG 2002), though much of this loss occurred in areas of dyked Bay of Fundy saltmarshes (69% loss; Bowron *et al.* 2012) that were likely never suitable for the aster. Some Annual Saltmarsh Aster occurrences may have been lost in the distant past because of these impacts,

especially where towns are present in formerly suitable habitat. The tidal nature of its habitat, however, limits new development. This has been especially true in the last 15 years since stronger wetland protection policies have been in place (NB DNRE / DELG 2002; PEI DEEF 2007; National Assembly of Quebec 2012). The direct impacts on occupied Annual Saltmarsh Aster habitats that are evident today are mostly from infilling for causeways and bridges built well before the ten year period relevant for assessment (AC CDC pers. obs. 1999-2015; Google Earth 2016) and as noted in **Threats –** *Transportation and Service Corridors*, the species can colonize these anthropogenic habitats.

Given the general private ownership of adjacent lands and proximity of occurrences to human settlement, very localized effects of dumping, infilling, or infrastructure construction (such as docks or boat launches) are probably occurring or can be expected in future, but no subpopulations are significantly affected by known, active threats at present (AC CDC botanists pers. obs. 1999-2015).

In the United States, Annual Saltmarsh Aster habitat is likely in a slow decline. Estuarine vegetated wetlands in the United States declined by 2.4% from 2004 to 2009 (Dahl and Stedman 2013), which represents a significant increase in wetland loss over previous studies (Dahl 2006).

BIOLOGY

Little specific information exists on the biology of Annual Saltmarsh Aster. Most information available refers to the genus, or related taxa, with that information augmented here by observations made in recent years.

Life Cycle and Reproduction

Annual Saltmarsh Aster is a self-compatible (Sundberg 2004), monoecious annual that blooms from late July to early October. No data are available on self-fertilization rates but the closely related halophytic annual Sea Aster (*Symphyotrichum tripolium*) is believed to be primarily or exclusively xenogamous (fertilized by pollen from other individuals; Krüger *et al*. 2002), as is the case with several other perennial *Symphyotrichum* species (Brouillet 1981; Jones 1978). As in many other aster species, late flowering individuals may be found until the first heavy frosts (Maine Natural Areas Program 2013). Seeds mature and are dispersed from late August to October via tidal inundation and wind, given that stalks generally lack seeds later in this period (AC CDC botanists pers. obs. 1999-2015).

Annual Saltmarsh Aster appears to set seed and germinate readily in the field (AC CDC botanists pers. obs. 1999-2015). As in many annuals, size at maturity and number of flower heads and seeds produced can vary substantially depending on site conditions. Tiny plants as small as 2 cm may have only one or a few flower heads, while the largest plants may have 60 or more flower heads, each potentially producing at least 4 to 10 seeds (Hinds and Flanders 1992; AC CDC botanists pers. obs. 1999-2015). Average time from germination to first flowering for seven Canadian subpopulations was 77 to 95 days under

propagation in a growth chamber for 28 days followed by growth in a greenhouse under winter day length with augmented artificial light (Hughes 2015). In the wild, these times would place germination between late May and late June. Hughes (2015) identified three growth stages: the seedling stage in which round and ovate basal leaves are produced; the vegetative stage characterized by shoot production and development of many large rounded leaves; and the reproductive stage in which many large rounded leaves are lost, small narrowly lanceolate leaves develop around the heads and the anthocyanin content of shoots increases, resulting in a dark purple colouration (Brouillet *et al*. 2006).

Hughes (2015) found that seeds germinated most readily on wet filter paper at 4^{o}C after abrasion of the seed coat with fine (220 grain) sandpaper. In saline environments, the germination of seeds occurs more often during rain events when soils are less saline and more suitable for germination (Chapman 1974; Ungar 1982). Nicol and Ward (2010) noted apparent suppression of germination by water with a specific conductivity exceeding 5,000 µS/cm (about 1/10th the salinity of seawater) in seed bank germination trials, but documented common occurrence at their field site in areas with double that salinity, suggesting that adult plants had a higher salinity tolerance than juveniles.

As an annual plant of variable and naturally disturbance-prone environments, seed banking is likely significant for Annual Saltmarsh Aster (e.g., Kalisz and McPeek 1992; Thompson 2000; Nunney 2002). Seed banking likely contributed to the major increase (35,900 to ~1,000,000) observed between 2013 and 2014 at the Condons Pond subpopulation. No seed bank research on the species has been conducted in Canada, but in a former salt mining site in Ohio, soil seed bank density was up to 2,632 seeds/m^2 (Egan and Ungar 2000). In South Australia, where the species is a widespread exotic, Annual Saltmarsh Aster was among the most abundant species in the soil seed bank of a brackish inland reservoir and river system, reaching seed densities of 184 seeds per m^2 (Nicol and Ward 2010). Seed longevity in Annual Saltmarsh Aster is unknown but short-term persistence is more frequent than long-term persistence in temperate saltmarsh species (Thompson *et al.* 1997; Wolters and Bakker 2002) and in the partially sympatric annual Gulf of St. Lawrence Aster, the persistent seed bank is relatively short-lived, with few seeds believed to survive in the soil longer than ten years (Kemp and Lacroix 2004; Environment Canada 2012).

The pollination biology of Annual Saltmarsh Aster is not well known, though it is noted as self-compatible (Sundberg 1986, 2004) and as an important nectar plant for native bees in the United States (Lady Bird Johnson Wildflower Centre 2016). Limited additional detail on specific pollinators is given below in **Interspecific Interactions**.

Physiology and Adaptability

The Annual Saltmarsh Aster is a halophytic species physiologically adapted to withstand contact with water and substrate influenced by dissolved salts. Mature plants can tolerate several hours of daily inundation in brackish waters, at a depth of over one metre (AC CDC botanists pers. obs. 1999-2015), although its absence from fully saline saltmarsh not influenced by a source of freshwater suggests a limit to its salt tolerance (AC CDC botanists pers. obs. 1999-2015).

Cultivation in garden and greenhouse experiments demonstrates that Annual Saltmarsh Aster grows readily in non-saline conditions (Hinds and Flanders 1992; Hughes 2015). Hughes (2015) also noted better survival of second generation Canadian plants grown in a greenhouse in short day-length conditions, compared to second generation New Jersey plants (7% vs. 30% mortality before maturity), suggesting that the higher survival may be indicative of greater flexibility or genetic adaptation to harsher, colder conditions in Canada.

Annual Saltmarsh Aster in the broad sense occurs across an exceptionally wide latitudinal range for a *Symphyotrichum* species (Kartesz 2015) extending from South America to southeastern Canada. Variety *subulatum* also has a broad latitudinal range from southernmost Texas to southeastern Quebec (Kartesz 2015; AC CDC 2016), which includes a broad range of mean annual temperatures and annual precipitation conditions. Mean annual temperatures at Brownsville, Texas, and Fort Myers, Florida, are 23.6°C and 23.95°C, respectively (U.S. Climate Data 2016a,b), while the mean annual temperature near the geographic centre of the Canadian population in Bathurst, New Brunswick, is 4.61°C (Environment Canada 2016). Annual precipitation ranges from 66 cm in southern Texas, to 168 cm near the Alabama and Florida border (Western Regional Climate Center 2016). Bathurst experiences an annual average of 108 cm, 31% of which occurs outside the growing season (Environment Canada 2016). Frost-free days range from 300 to 365 in southern Florida and southern Texas (Internet Accuracy Project 2016), to 120 to 140 in the inner Chaleur Bay in New Brunswick and Quebec (Government of Canada 1981).

Dispersal and Migration

As an annual, Annual Saltmarsh Aster achieves both local spread and long-distance dispersal entirely via movement of seeds by wind, tidal and freshwater currents, and probably by waterfowl and other bird and mammal species. Movement by water is clearly important. Most plants are submerged daily by tides, are at or near areas with strong river currents and the species has seeds capable of floating for prolonged periods. Seed flotation times in a laboratory experiment averaged 38 ± 7 days in brackish water (15 ppt dissolved salts), 62 ± 6 days in freshwater (0 ppt dissolved salts), and 45 ± 8 days in saltwater (36 ppt dissolved salts) (Elsey-Quirk *et al.* 2009b). Assuming seed viability is maintained over this period (which is not known for certain), currents could thus move the seeds considerable distances.

The hairy pappus on the seeds promotes wind dispersal and increases likelihood of movement via attachment to animal fur or feathers. Vivian-Smith and Stiles (1994) found seeds of Perennial Saltmarsh Aster (*Symphyotrichum tenuifolium*, a closely related sympatric species in the United States) on Brant (*Branta bernicla*, a migratory goose), suggesting that long-distance dispersal events, although presumably infrequent, could occur. Adventive occurrences have not yet been reported in Atlantic Canada, but human-assisted dispersal has resulted in an ongoing spread far beyond the natural range into the Great Lakes region (Mohlenbrock 2002; Oldham, pers. comm. 2016; Reznicek pers. comm. 2016) and the southern United States (Brouillet *et al*. 2006) that may eventually reach disturbed habitats in Atlantic Canada.

Interspecific Interactions

Few interactions with other species are noted in the literature. The species occurs in sparsely vegetated habitat subjected to twice-daily inundation of brackish water, where species richness and competition is relatively low. Competition with more robust, patch-forming saltmarsh perennial plants such as Saltmarsh Cordgrass seems to be a limiting factor, based on more limited occurrence within dense patches than in more open habitat (AC CDC botanists pers. obs. 1999-2015). Asters, including *Symphyotrichum* species, are visited by a variety of generalist insect pollinators, including bees, wasps, flies, moths, butterflies, and beetles (Jones 1978; Semple *et al.* 1996; Robson 2010). It is not known which insect species visiting *Symphyotrichum* flowers act as effective pollinators[3]. There is extensive literature on insect herbivores and seed predators of asters but no details on seed or vegetative herbivory specific to Annual Saltmarsh Aster could be found, aside from notation of it being of low palatability for grazing and browsing animals (USDA NRCS 2016) and as a food of Rock Hyrax (*Procavia capensis*) in Jordan (RSCN 2016). Jacques Labrecque (pers. comm. 2016) noted that all of the 26 plants he observed at the small Escuminac River subpopulation in Quebec had been heavily grazed by White-tailed Deer (*Odocoileus virginianus*) and were reduced to small secondary shoots. This had not been noted at the same site in 2015 (AC CDC botanists pers. obs. 1999-2015) when 1,100 plants were recorded. Animal-mediated dispersal is discussed above in **Dispersal and Migration**.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Population counts in this report were mostly derived from AC CDC fieldwork in 2013 and 2015. All counts should be considered very rough estimates of actual numbers. Fieldwork was mostly focused on documenting new occurrences in sites not previously surveyed, and on ensuring all previously known sites were visited. The focus on visiting many sites limited the extent to which systematic sampling could be undertaken to derive counts.

Field survey localities for potential new sites were selected based on lack of previous botanical survey, potential for conditions of moderated salinity (freshwater rivers near head of tides, or estuaries with multiple freshwater inflows) based on aerial photograph examination, and proximity of known sites. The Richibucto River and Miramichi Bay estuaries were areas of special focus in 2015 because of extensive potential habitat at numerous freshwater inflows and several new occurrences discovered in 2013. Fieldwork in 2013 had also expanded the known range northward, leading to the 2015 visits to sites in

[3] Fothergill and Vaughn (2010) document five species of butterflies and skippers visiting Annual Saltmarsh Aster in Missouri including Red Admiral (*Vanessa cardui*) and Orange Sulphur (*Colias eurytheme*), which occur commonly in the Canadian Maritimes (AC CDC 2016). Annual Saltmarsh Aster is not otherwise known in Missouri, strongly suggesting that the report actually refers to another aster species.

Quebec. Failure of earlier studies to find any sites in New Brunswick's Acadian Peninsula, (the northeastern region between Bathurst Harbour and Miramichi Bay), resulted in the region not being surveyed further in 2015.

Available habitat at survey sites was extensively covered, usually from head of tide downstream to the end of the subpopulation for river sites. The only subpopulation with extensive unsurveyed high potential habitat is the 6 km of the Black River downstream from known sites toward occurrences on Palmer Cove and Little Black River. Thus numbers could be significantly underestimated for that subpopulation. Most subpopulation counts are sums of numerous individual points at which counts (for small numbers) or visual estimates (for larger numbers) were made. The large Condons Pond, Charlo River, Jacquet River and Cape Jourimain subpopulation counts were derived largely or entirely from extrapolation of small-scale counts over larger areas. Other counts derived from summing point totals probably tend to underestimate population because they assume complete detection. In summing the field records from AC CDC (2016) to get subpopulation totals, when counts were provided in a range (e.g., 50-100), the midpoint of the range was used (e.g., 75). When "greater than" symbols (>) were used, the reported value was rounded up by 10%. When values were expressed on a logarithmic scale (e.g., hundreds, thousands) the unit's median value was used (e.g., hundreds to 500, thousands to 5000).

Abundance

The total native Canadian population of Annual Saltmarsh Aster is roughly estimated to be between 1,410,100 and 445,000 (Table 1), with the uncertainty because of major inter-annual variation at the Condons Pond, Prince Edward Island, and Escuminac River, Quebec, subpopulations (see **Fluctuations and Trends**, below). Except for the above sites, where numbers were provided by Rosemary Curley (pers. comm. 2016), Karen Samis (pers. comm. 2016) and Jacques Labrecque (pers. comm. 2016), population estimates are from AC CDC (2016) based on fieldwork between 2003 and 2015, with over 95% of data points from 2013 to 2015. The numbers by subpopulation, especially for the sites with the largest numbers, represent rough estimates because the primary goal of fieldwork was to document presence and spatial extent of occurrence at each site (see **Sampling Effort and Methods**).

The five largest populations (Condons Pond, Charlo River, Jacquet River, Cape Jourimain and Bass River) support between 91% and 97% of the Canadian population. Eight subpopulations are estimated at 1,000 to 8,150 plants each, and an additional four subpopulations are small with an estimated 200 to 600 plants each.

Fluctuations and Trends

Available data for Annual Saltmarsh Aster allow only minimal direct assessment of year-to-year or long-term changes in total population. However, all sites ever recorded in the native Canadian range going back to the early 1900s appear to remain extant (Table 1) and there is no indication of major habitat alteration since the original status report in 1994 (AC CDC botanists pers. obs. 1999-2015). There is, therefore, no basis for inferring a change in the Canadian population.

Canadian population estimates were “several thousand” in Hinds and Flanders (1992; three subpopulations) and 16,550 in Hoyt (2003; five subpopulations), with the latter noted as being a very rough estimate that was probably lower than the actual population. Comparison of Hoyt (2003) subpopulation counts with current counts are (Hoyt’s vs. current): Tetagouche River (100 vs. 602), Nepisiguit River (100 vs. 2,100), Middle River / Little River (16,000 vs. 5,937), Teagues Brook (100 vs. 7,000), and Bass River (250 vs. 13,000). It is unclear if instances of higher estimates reflect actual change or the generally more intensive and systematic nature of recent surveys. The apparent decline at Middle River / Little River is within the scale of annual fluctuation described below, and is also likely within the margin of error around the 2004 and 2015 subpopulation estimates (both noted as being rough estimates), meaning that it does not necessarily represent a significant decline.

There is direct evidence of major year-to-year variation within the Condons Pond, Prince Edward Island subpopulation, with larger numbers recorded in the two more recent visits. Rosemary Curley (pers. comm. 2013), noted that water levels were considerably lower and numbers, density and area occupied by Annual Saltmarsh Aster at Condons Pond were all substantially higher in 2013 (when the population was estimated at 35,900) than had been the case when the site was discovered in 2003. Karen Samis’ observations in 2014 (pers. comm. 2016) found a massive additional increase over 2013 numbers, with the aster densely covering large areas of drained pond and numbers roughly estimated at about 1,000,000. Data are insufficient to classify this as a permanent increase and it may be more likely to represent a fluctuation. If the pond outlet is again blocked by natural sand deposition, available habitat will be much reduced by flooding, while if the pond remains at low levels, more competitive perennial saltmarsh vegetation will likely become established in some areas, also resulting in reduced ideal aster habitat.

In 2016, Labrecque (pers. comm. 2016) revisited the Escuminac River, Quebec subpopulation discovered in 2015 and found only 26 plants, all heavily grazed by White-tailed Deer, although it is not clear that all habitat visited in 2015 was searched in 2016. The potential for major year-to-year increases, probably significantly influenced by recruitment from multi-year seed banks, means that additional observation would be required in order to confirm that this observation represents a significant population decrease.

Hoyt (2003) noted that the Nepisiguit River subpopulation had about 100 plants in 2001 but no plants could be found in the same site in 2002. As an annual plant occurring in a dynamic habitat that can be altered by storms and ice action and which may succeed to less suitable dense perennial communities in the absence of such disturbance, substantial population fluctuations at an individual site are not unexpected (Nunney 2002). Another rare annual aster of Maritimes saltmarshes (Gulf of St. Lawrence Aster) is known to vary by at least an order of magnitude, and to disappear temporarily from the above-ground vegetation at occupied sites (COSEWIC 2004). Direction and magnitude of short-term changes across the hundreds of kilometres of shoreline within the Canadian range of Annual Saltmarsh Aster would seem unlikely to be uniform. If, however, variation of the magnitude observed at Condons Pond (~28 times increase in one year) happened to occur simultaneously in two or more subpopulations, and no fluctuations in the opposite direction occurred, the Canadian population could undergo a “extreme fluctuation” of one order of magnitude in mature individuals, yet the seed bank is not likely to be exhausted.

Rescue Effect

The 450 km distance between the nearest United States occurrences in southern Maine and Canadian occurrences in southeastern New Brunswick makes natural rescue within the documented Canadian native range unlikely. Although no roadside occurrences are known in New Brunswick or in Maine, the documented spread of Annual Saltmarsh Aster along saline highway ditches elsewhere (Catling and McKay 1980, 1981; Voss 1996; Mohlenbrock 2002, who notes “rapidly spreading in northeast Illinois”; Semple *et al.* 2002) does provide a plausible means by which spread from American occurrences into Canada, and potentially into the native Canadian range, could occur over a shorter time span. The spread of other halophytes and roadside specialist plant species over hundreds of kilometres within ten to fifteen years has been documented in the Maritimes (e.g. Stinkwort [*Dittrichia graveolens*], Jerusalem Oak [*Chenopodium botrys*], Rayless Annual Aster [*Symphyotrichum ciliatum*]; AC CDC 2016), and rapid spread of ecologically similar species on major highways is well known in the literature (Catling and McKay 1980, 1981; Reznicek and Catling 1987; Oldham and Klymko 2011).

THREATS AND LIMITING FACTORS

Threats

Current data suggest that the majority of Annual Saltmarsh Aster subpopulations in Canada are not facing any severe, imminent threats. Furthermore, the separation distance between most subpopulations greatly limits the likelihood of any single event affecting a majority of subpopulations simultaneously. The recent threats assessment rates the range-wide threat impact as “low” (see Appendix 1).

Where potential risks have been identified, the most serious plausible threats are from habitat loss or alteration associated with: (a) Recreational Activity, (b) Residential and Commercial Development, (c) Transportation and Service Corridors, and (d) Climate Change and Severe Weather.

Two other plausible site-specific threats have also been identified: agriculture and invasive species. However, there is a higher level of uncertainty around the severity and imminence of these threat factors. Consequently, they tend to fall under the category of "threats where the imminence and harm are both hypothetical but possible" (COSEWIC 2011). All threats are listed below under their corresponding IUCN threats classification scheme headings (IUCN 2016).

Tourism and Recreational Areas (1.3)

This threat category includes recreational activities of residents from impacts associated with existing residential presence and future residential development adjacent to Annual Saltmarsh Aster occurrence. These impacts from residences are generally not from the houses themselves because of the flood-prone nature of aster habitat and because of provincial wetland regulations, but rather from activities associated with recreation such as construction and use of docks, trails, fire pits or boat launches. Other activities often found around residences but not associated with recreation (infilling, dumping of yard waste, mowing or trimming shoreline vegetation) are covered under *Residential and Commercial Development* below.

Typical recreation-associated activities such as construction and use of docks, trails, firepits or boat launches likely occasionally affect Annual Saltmarsh Aster and can be presumed to continue to do so through the future. New development is not rapid, because most of the aster's Canadian range is within zones in which the human population is decreasing (Statistics Canada 2016), but waterfront land is likely to be relatively desirable for new residences. Observations of direct impacts are very limited (AC CDC botanists pers. obs. 1999-2015), but most subpopulations extend over multiple landowners and thus would be unlikely to be eliminated even with intensive impacts. Further, there is potential for tolerance and recovery from any impacts in which substrate remains suitable and adjacent aster populations are retained, and the likelihood of these conditions is considered to be high (see discussion under Transportation and Service Corridors, below).

Transportation and Service Corridors (4)

Roads, bridges and causeways extending up to or through Annual Saltmarsh Aster habitat are known at Jacquet River, Beresford, Teagues Brook, Middle/Little River, Napan River, Black River (Black River and Little Black River sites), Bay du Vin River, and Mill Brook in the Richibucto River subpopulation, and similar structures are present near the aster at several other sites. Active railroads cut through the estuaries of Escuminac River, Charlo River and Jacquet River within a few hundred metres of Annual Saltmarsh Aster occurrences and may have eliminated some aster habitat by restricting tidal flow on their landward sides (AC CDC botanists pers. obs. 1999-2015). A dredged channel, probably

associated with log driving, was also cut through the Escuminac River subpopulation (AC CDC botanists pers. obs. 1999-2015). All of these corridors were constructed well before the ten year period relevant for status assessment, and ongoing impacts appear to be low (AC CDC botanists pers. obs. 1999-2015). There are seven occurrences where small numbers of the aster have colonized the artificial or semi-natural shores of causeways or bridge abutments (Beresford, Little River, Little Black River, Black River, Bay du Vin River; AC CDC botanists pers. obs. 1999-2015), further suggesting that direct habitat impacts from road construction are not a major threat if a good number of plants remain nearby but outside the area of impact.

Recreational Activities (6.1)

AC CDC botanists' fieldwork (pers. obs. 1999-2015) found minor habitat impacts from recreational activities at three subpopulations. At Black River some plants occurred at the margins of a well-used public boat launch. At Cape Jourimain National Wildlife Area several hunting blinds are present on aster-occupied shoreline, and at Beresford most of the Annual Saltmarsh Aster plants occur in an estuarine saltmarsh within the Beresford Beach Municipal Park that has a large parking area for beach use, a boardwalk through the saltmarsh and playgrounds and baseball fields extending to the edge of the saltmarsh. A group of six cottages is present in an old field area fronting on the downstream edge of the Bass River subpopulation and there is potential for expansion of cottage development at that site. All-terrain vehicle use also occurs to some extent on some aster-occupied shores at low tide (AC CDC botanists pers. obs. 1999-2015). None of these activities are believed to be having impacts on any subpopulation numbers at present nor are they expected to in the near future (AC CDC pers. obs. 1999-2015).

Residential and Commercial Development (1)

Many Annual Saltmarsh Aster occurrences are on shores fronting residential properties, with lawns often extending right to the tidal zone, or with the tidal zone only buffered by a few metres of unmanaged vegetation between lawn and shore. Shores below the high water mark are technically Crown land, although adjacent landowners frequently alter shorelines beyond their property boundaries. Numerous other occurrences are on more natural shores but within a few hundred metres of a home. Houses occur within 100 m of Annual Saltmarsh Aster plants at Jacquet River, where only two houses are present, at the Miramichi Bay subpopulations, and at the Middle River / Little River subpopulation. House density is fairly high at the Eel, Portage, Black, and Napan subpopulations on Miramichi Bay. In these sites more than 200 houses are distributed roughly every 100 m along roads which are present on both sides of each river, though houses are mostly more than 100 m from the river. Density of houses is even higher within a large portion of the Middle River / Little River subpopulation, where 14 houses occur along 800 m of aster-occupied shoreline, and all houses are within 80 m of the waterfront.

Outreach to relevant landowners has been very limited for Annual Saltmarsh Aster, especially on the sites away from Bathurst Harbour, meaning that very few would be aware of its presence or significance. The close proximity of many homeowners to Annual Saltmarsh Aster is thus of some concern, because local impacts from typical rural activities such as dumping or infilling (authorized and unauthorized), are probably occurring to a limited extent or can be expected in future. The New Brunswick permitting process for Wetland and Watercourse Alterations (which would apply to any legal infilling or dock construction) does not include a specific check for the presence of legally protected species and thus would not necessarily provide protection to Annual Saltmarsh Aster.

Infilling and dumping have not, however, been noted as significant problems in extensive recent fieldwork (AC CDC botanists pers. obs. 1999-2015), and as described under **Threats** and elsewhere below, Annual Saltmarsh Aster is relatively resilient to human disturbance if some plants remain nearby and if suitable substrate is still present.

Climate Change and Severe Weather (11)

Rising sea levels and increasing storm frequency and severity associated with climate change could directly affect the often narrow bands of intertidal gravel and mud substrate utilized by Annual Saltmarsh Aster (see **Habitat Requirements**) and perhaps more significantly, could breach barrier dunes causing increased estuarine salinity (Hauck *et al*. 2009; see notes on aster sensitivity to salinity in **Physiology and Adaptability** and **Habitat**) and loss of saltmarsh because of stronger wave impacts (Leatherman 1979; Day *et al.* 2000). Most Annual Saltmarsh Aster occurs on estuarine sites in which barrier dunes currently regulate tidal flushing, moderating salinity. All Annual Saltmarsh Aster subpopulations except for Escuminac River, Quebec are protected by barrier dune or beach systems. These are: the three large dune systems that form the estuaries of Bathurst Bay (Tetagouche, Middle / Little, and Nepisiguit river subpopulations); the Richibucto River and Miramichi Bay (six subpopulations); the dune system forming the medium-sized Beresford estuary (one subpopulation), and the much smaller and potentially most threatened barrier beaches forming the estuaries of Charlo River, Jacquet River, Bass River, Teagues Brook, Cape Jourimain, and Condons Pond. Each of these latter systems supports a single subpopulation. Recent breaching of barrier dunes and loss of coastal land is widespread in the range of Annual Saltmarsh Aster (*e.g.* Turcotte-Lanteigne and Ferguson 2008) and has already been noted reducing populations of a rare specialist coastal plant species in New Brunswick and Prince Edward Island (Beach Pinweed, COSEWIC 2008). There has been concern among local landowners about the potential for breaching of the low barrier dune at the Charlo River subpopulation, which contains roughly 54% of the Canadian population (Mazerolle pers. comm. 2016).

Sea levels in the Northumberland Strait between Prince Edward Island and New Brunswick are predicted to rise by at least 0.50 m to 0.60 m by 2100 (Intergovernmental Panel on Climate Change 2013; Craik *et al.* 2015). Sea-level rise is considered a “serious threat to the persistence of coastal habitats and their associated species” (Intergovernmental Panel on Climate Change 2013; Craik *et al.* 2015) and could be significant for occurrences where shoreline hardening or steep slopes will prevent landward

migration of shoreline communities. Annual Saltmarsh Aster is, however, specifically adapted to take advantage of sites experiencing frequent natural disturbances and is relatively capable of local scale dispersal by wind and water (see **Dispersal and Migration**). Most subpopulations offer fairly extensive linear occurrence of potentially suitable habitat and include areas of undeveloped shoreline (AC CDC botanists pers. obs. 1999-2015) meaning that landward migration of suitable habitat could occur with sea level rise. Additionally, as a southern species at its northern range limit, any climatic limitation could be eased in a warmer climate. There is thus reason to predict that Annual Saltmarsh Aster will be relatively resistant to the effects of climate change in areas where salinity is not affected, though the specific impacts of multiple interacting climate change-related issues are hard to predict for any species (Pearson and Dawson 2003; Dawson *et al.* 2011).

Problematic Native Species (8.2) – White-tailed Deer

Jacques Labrecque (pers. comm. 2016) recorded that all of the 26 plants he was able to find in the Escuminac River, Quebec, subpopulation were heavily grazed by White-tailed Deer and were reduced to small secondary shoots. Deer grazing has not been observed in any other subpopulations (AC CDC botanists pers. obs. 1999-2016), and was not observed at Escuminac River in 2015 (AC CDC botanists pers. obs. 1999-2016). Deer populations within Annual Saltmarsh Aster range are far below densities occurring in areas where major ecological effects are observed, only reaching densities above two deer / km^2 in local pockets with maximum densities unlikely to exceed 10 deer / km^2 (Kennedy pers. comm. 2016). Estimates of pre-European settlement deer density in “most favorable habitat” (well south of New Brunswick) range from 3.1 to 7.7 deer / km^2 (see references in Horsley *et al*. 2003). Additionally, salt marshes are not considered prime feeding areas for White-tailed Deer in the Canadian Maritimes (Kennedy pers. comm. 2016). Thus it does not seem likely that deer grazing is currently a major issue for Annual Saltmarsh Aster across its Canadian range. As an annual species, however, seed production is critical for long-term maintenance of Annual Saltmarsh Aster populations. If herbivory was consistently at levels that greatly reduced seed production for a decade or more (the speculated typical longevity of seeds in the seed bank for the related saltmarsh species Gulf of St. Lawrence Aster, Kemp and Lacroix 2004), it might present a significant issue for an affected subpopulation.

Agriculture (2)

Annual Saltmarsh Aster occurrences are found on the frontage of active farms on several rivers. The saltmarsh supporting the Jacquet River subpopulation abuts a single large farm with a hayfield that extends to the saltmarsh margin and is within 40 m of known aster occurrence. The 5.8 km of river occupied by the aster on the Napan River has several large farms and there are at least three active farms along the aster-occupied area of the Little Black River (Black River subpopulation). Other smaller farms that may no longer be active are present along these rivers and some other Miramichi Bay subpopulations (Google Earth 2016). Most of the Mill Brook occurrence (Richibucto River subpopulation) is also within the frontage of a single farm. No significant impacts from agricultural activities have been noted (AC CDC botanists pers. Obs. 1999-2015), but potential exists for

agricultural landowners to create impacts similar to those noted under *Residential and Commercial Development* (dumping, infilling, or construction of docks, trails or boat launches).

Invasive Non-native/Alien Species (8.1)

Invasive exotic species are not currently a significant threat to Annual Saltmarsh Aster. Purple Loosestrife (*Lythrum salicaria*), was observed in the Tetagouche River subpopulation in 2013 near the upper margin of the estuary's brackish water zone but was not particularly abundant (Mazerolle pers. comm. 2016) and it is not known to invade brackish habitats significantly in the region (AC CDC botanists pers. obs. 1999-2015). The main invasive exotic species that might affect Annual Saltmarsh Aster in the future is the European Common Reed (*Phragmites australis* ssp. *australis*) which is a very significant invader of brackish marshes and other wetlands in the northeastern United States (Chambers *et al.* 1999; Vasquez *et al.* 2005; Buchsbaum *et al*. 2006; Mozder and Zieman 2011). This taxon is present but still rather rare in New Brunswick (AC CDC 2016) and is not yet known to be affecting undisturbed saltmarshes significantly. The tendency for Annual Saltmarsh Aster to occur in the more highly ice- and current-affected portions of occupied marshes (i.e., those with high disturbance regimes) may reduce the impacts of European Common Reed and invasive species generally by preventing the establishment of very dense patches (AC CDC botanists pers. obs. 1999-2015).

Limiting Factors

In Canada, Annual Saltmarsh Aster is almost exclusively found in a relatively restricted zone of tidal brackish waters where salinity is reduced in comparison with ocean levels but where halophytic plants still predominate (see **Habitat**). These habitats are not rare but represent only a very small proportion of the landscape in Atlantic Canada. The limited distance of this zone along individual rivers seems to be a major factor limiting distribution within occupied watercourses. The species is also a specialist of areas of low standing biomass, bare soil and low competition, which further limits the extent of its occurrence at occupied sites so that it is most frequent at the outer edges of saltmarsh vegetation.

At a broad scale, available habitat does not appear to be a major limiting factor in Canada, as many of the sites searched for the species unsuccessfully within the Canadian range of Annual Saltmarsh Aster (Figure 4) have apparently suitable but unoccupied habitat (AC CDC pers. obs. 1999-2015). This fact would suggest that dispersal into Canada from more southern subpopulations and dispersal from Canadian subpopulations to other suitable Canadian sites may be important limiting factors. Presumed climatically suitable habitat is also fairly widespread outside the species' known range in southern Nova Scotia, in the Northumberland Strait region of northern mainland Nova Scotia and on the Bras d'Or Lakes (which are actually a large brackish tidal bay) in Cape Breton Island, but extensive fieldwork by AC CDC and others has never documented the aster in these areas (AC CDC 2016), lending further support to the idea that dispersal limitations may be significant.

The absence of Annual Saltmarsh Aster from the Bay of Fundy coast and from the Atlantic side of Nova Scotia may be a result of colder microclimates associated with nearshore waters that are colder and deeper than in areas occupied by the species in the Gulf of St. Lawrence. Because the Canadian occurrences of the species are the northernmost in the world, it is reasonable to predict that factors related to cold temperatures may be significantly limiting in Canada.

No other limiting factors affecting plant establishment, fecundity and mortality are understood at present.

Number of Locations

For the purposes of COSEWIC assessment, a 'location' is an area in which a single threatening event can rapidly affect all individuals present (COSEWIC 2015). Determining locations depends upon interpretation of threats. As detailed under **Threats**, no threats are considered both high magnitude and imminent. Threats are either small habitat disturbances associated with residences, agriculture, roads, railways or recreational activity that would generally affect only small portions of individual subpopulations and could happen on the short term, or are broad habitat alteration (increased salinity or loss of habitat) associated with climate change that could affect large portions of a subpopulation but with effects that are less clear and more distant in time.

Four possible interpretations relative to number of locations are presented below, with the first interpretation accepted in this report:

1) No threats are of sufficient magnitude and/or immediacy to warrant defining locations. Each of the 18 subpopulations represents one location (18 locations).

2) Climate change effects, especially the potential breaching of barrier beaches that currently moderate salinity through regulation of tidal flushing and protect saltmarshes from heavy wave impacts, are the most significant threats for each site, and,

    2a) Each subpopulation is a separate location because each is uniquely affected by climate change impacts because of differences in landforms and adjacent land use that affect the extent to which shoreline habitats can migrate landward (18 locations, or more locations if a finer analysis of potential climate change effects and subpopulations were divided on that basis), or,

2b) Subpopulations are grouped into locations based on the barrier dunes that protect them. Each of the ten barrier dune systems[4] represents one location, and the Escuminac, Quebec subpopulation (not protected by a barrier dune but with good resilience to sea level rise[5]) is another location (11 locations; see Table 1).

3) Effects of small scale threats associated with adjacent landowners (see **Threats** – Recreational Activities and Residential and Commercial Development) are considered more significant than climate change-associated threats at all subpopulations (205 locations, or up to a maximum of 437 locations). The number of locations could be as high as 437 based on the number of properties fronting Annual Saltmarsh Aster estuaries using data from Service New Brunswick (2016), and considering that Cape Jourimain National Wildlife Area and Condons Pond, Prince Edward Island (both Crown land) and the Escuminac River subpopulation (no significant threat from residential landowners) each represent single locations. Residential landowners are much less likely to cause significant impacts in Annual Saltmarsh Aster habitat well away from shores as compared to occurrences along residential shorelines. Thus a more realistic estimate of number of locations based on this threat is 205, equalling the number of properties with Annual Saltmarsh Aster occurrences inside or within 25 m of their boundaries.

The number of Annual Saltmarsh Aster locations in Canada is thus estimated at 18, but could be as high as 437 if small scale human impacts were considered most significant at all sites.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Currently, Canadian legal status and protection apply only to "Bathurst Aster" (*Aster subulatus* var. *obtusifolius*, see **Name and Classification**) and not to subpopulations at Cape Jourimain, New Brunswick and Condons Pond, Prince Edward Island that would have been considered *Aster subulatus* var. *subulatus* in the strict sense under earlier taxonomy. Bathurst Aster was assessed as Special Concern in Canada by COSEWIC in 1992 and has been listed as Special Concern under Schedule 3 of the *Species at Risk Act*

[4] Barrier dunes are forming the large estuaries of Bathurst Bay (Tetagouche, Middle / Little, Nepisiguit river subpopulations), Richibucto River (two subpopulations) and Miramichi Bay (nine subpopulations), the dunes forming the medium-sized Beresford estuary, and the much smaller and potentially most readily impacted estuaries of Charlo River, Jacquet River, Bass River, Teagues Brook, Cape Jourimain, and Condons Pond.

[5] At the Escuminac River subpopulation, a sandspit extends across only 250 m of the 850 m estuary mouth. Sea level rise would affect the alluvial gravel habitat occupied by Annual Saltmarsh Aster at the river mouth, but the aster is well away from the current upland boundary and the site thus offers good potential for landward habitat movement with sea level rise. Aster occurrences are well protected from impacts associated with nearby residences because only one residence fronts directly on the saltmarsh and it is 200 m from the nearest aster occurrence. All other frontage on the estuary is buffered by at least 50 m of forest with the asters at least 75 m out from shore in the marsh and all other nearby residences are separated from the estuary by a railroad bed. Potential for impacts from adjacent residential landowners is therefore minimal.

since the Act's proclamation in 2003. A Schedule 3 listing applies to species listed as Special Concern under assessments done more than two years prior to 2003. The listing of a species on Schedule 3 does not confer any protection for a species or its habitat (Minister of Justice 2015). In New Brunswick, Bathurst Aster (all subpopulations except for Cape Jourimain) is listed as Endangered and its habitat is protected under the Prohibition Regulation (2013-39) of the New Brunswick *Species at Risk Act* (Legislative Assembly of New Brunswick 2012). Neither Bathurst Aster nor Annual Saltmarsh Aster has any legal protection under Prince Edward Island or Quebec laws, although in Quebec it was only discovered in 2015 and it may eventually become listed as Threatened (the category of highest threat) under chapter E-12.01 of the provincial *Act Respecting Threatened or Vulnerable Species*, which would protect the species and its habitat (Province of Quebec 2016).

Annual Saltmarsh Aster is listed as Threatened in Maine, where it receives protection through the state's *Natural Resource Protection Act* and under Maine's Site Law, which governs approval for development (Cameron pers. comm. 2013). It is also protected as a Threatened species in New York under New York State *Environmental Conservation Law* section 9-1503 (Young 2010).

Non-Legal Status and Ranks

NatureServe (2016) lists state level ranks for Annual Saltmarsh Aster as Not Ranked (SNR, which frequently indicates an absence of conservation concern because most jurisdictions have only given numeric ranks to species considered of concern) in New Hampshire, Massachusetts, Rhode Island, Connecticut, Pennsylvania, New Jersey, Maryland, South Carolina, Tennessee, Florida, Alabama, Mississippi, Louisiana, Oklahoma, and Texas. It is also listed as SNR in Illinois, Indiana, Michigan, and Ohio, where it is believed introduced, and it is listed as Introduced (SNA) in Hawaii. The species is Demonstrably Secure (S5) in Virginia and Apparently Secure (S4) in Georgia and Delaware. Annual Saltmarsh Aster is Critically Imperilled (S1) in Maine and Prince Edward Island, Critically Imperilled to Vulnerable (S1S3) in Nebraska, Imperilled (S2) in New York and New Brunswick and is Vulnerable to Apparently Secure (S3S4) in North Carolina. It is not yet ranked (SNR) for Quebec but would qualify as Critically Imperilled (S1; Labrecque pers. comm. 2016). It is reported for Arkansas as a rare native species in Kartesz (2015), but it has no NatureServe rank (NatureServe 2016; Steinauer pers. comm. 2016). The reports from Arkansas are based on Nesom (2004), who cites potentially native records associated with semi-natural or heavily disturbed habitats. The ranks for Nevada (Critically Imperilled, S1) and New Mexico (Not Ranked, SNR) represent the southwestern varieties *parviflorum* or *ligulatum* (=*Symphyotrichum expansum* and *S. divaricatum*). The national ranks of the Annual Saltmarsh Aster are Demonstrably Secure (N5) in the United States and Imperilled (N2) in Canada, and the Global Rank is Demonstrably Secure (G5).

Habitat Protection and Ownership

Most or all Annual Saltmarsh Aster in Canada occurs below the Ordinary High Water Mark, which generally represents the upper limit of Crown jurisdiction in tidal waters (East Coast Environmental Law 2010). Because the species occurs near the boundaries of land and water and land owners may modify saltmarsh below the high water mark as if it were part of their property, ownership of adjacent land fronting occurrences is relevant.

The great majority of the land adjacent to the 18 subpopulations is privately owned. The City of Bathurst owns a large portion of one marsh at the margins of the Bathurst Harbour subpopulation and about 15-20% of the frontage at that subpopulation is provincial Crown land, as is 620 m of frontage on the Bay du Vin River subpopulation, supporting about 2,000 plants. Most of the frontage around the Beresford subpopulation is part of the Beresford Beach Municipal Park owned by the Town of Beresford.

Provincially significant wetlands in New Brunswick are protected under the Watercourse and Wetland Alteration (WAWA) Regulation of the New Brunswick *Clean Water Act* and the Environmental Impact Assessment Regulation of the New Brunswick *Clean Environment Act*. Development within these areas requires special permitting but the WAWA regulation does not necessarily protect Annual Saltmarsh Aster when development is permitted because permits are issued without determining whether legally protected species are present. Based on documented distribution the following subpopulations are entirely within provincially significant wetlands as mapped at GeoNB (2016): Cape Jourimain, Napan River, Janeville, Bass River, Nepisiguit River, Tetagouche River, Beresford, Jacquet River and Charlo River. Mill Creek, Black River and Little River / Middle River subpopulations have significant portions within provincially significant wetlands. Other New Brunswick subpopulations (Mill Creek / Childs Creek, Portage River, Eel River / Meadow Brook, Bay du Vin River, Little Black River and Bartibog River) are mostly or entirely outside currently designated provincially significant wetlands. The Condons Pond, Prince Edward Island subpopulation is on provincial Crown land (Curley pers. comm. 2016). The Escuminac River, Quebec subpopulation is also on Crown land of unknown jurisdiction (provincial vs. federal; Labrecque pers. comm. 2016). The only occurrence within a designated protected area is on the federal Crown land of the Cape Jourimain National Wildlife Area which supports a roughly estimated 11% of the Canadian population, in which it is technically prohibited to “damage, destroy or remove a plant” (Department of Justice 2010), though in practice hunters construct blinds in occupied habitat at the marsh edge (AC CDC botanists pers. obs. 1999-2015). There are no known stewardship agreements in place with private landowners.

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BIOGRAPHICAL SUMMARY OF REPORT WRITER(S)

Sean Blaney is the Executive Director and Senior Scientist of the AC CDC, where he is responsible for maintaining status ranks and a rare plant occurrence database for each of the three Maritime provinces. Since beginning with AC CDC in 1999, he has discovered dozens of new provincial vascular plant records and documented over 15,000 rare plant occurrences during extensive fieldwork across the Maritimes. Sean is a member of the COSEWIC Vascular Plant Species Specialist Committee, and the Nova Scotia Atlantic Coastal Plain Flora Recovery Team, and has authored or co-authored numerous COSEWIC and provincial status reports. Prior to employment with ACCDC, Sean received a BSc in Biology (Botany Minor) from the University of Guelph and an MSc in Plant Ecology from the University of Toronto, and worked on biological inventory projects in Ontario as well as spending eight summers as a naturalist in Algonquin Park, where he co-authored the second edition of the park's plant checklist.

Alain Belliveau holds a Master's degree in Resource and Environmental Management where several courses and a field placement focused on Atlantic Coastal Plain Flora and Nova Scotia flora in general. He gained years of experience with the Mersey Tobeatic Research Institute in southern Nova Scotia, working on various plant and ecosystem-related research projects. Since 2013, Alain has worked as a botanist for the AC CDC, a position requiring extensive knowledge of the region's native and exotic flora. Alain has been contributing his growing expertise to COSEWIC documents for over five years, including the recovery strategy, management plans, and status reports for Atlantic Coastal Plain Flora.

COLLECTIONS EXAMINED

All relevant Canadian specimens have been databased in AC CDC (2016), so no collections were examined for the preparation of this status report.

Appendix 1: Threats Classification Table for Annual Saltmarsh Aster.

THREATS ASSESSMENT WORKSHEET

Species or Ecosystem Scientific Name	Annual Saltmarsh Aster (*Symphyotrichum subulatum*)
Element ID	**Elcode**
	28/10/2016
Assessor(s):	Mary Sabine, Ruben Boles, Jacques Labrecque, Jeannette Whitton, Jennifer Doubt, Bruce Bennett, and Sean Blaney.
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	2	2
Calculated Overall Threat Impact:		Low	Low
Assigned Overall Threat Impact:		**D = Low**	
Impact Adjustment Reasons:			
Overall Threat Comments			

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 - Slight (1-70%)	High - Moderate	
1.1	Housing & urban areas		Negligible	Negligible (<1%)	Negligible (<1%)	Insignificant/Negligible (Past or no direct effect)	Direct housing impacts are unlikely because of frequent flooding and wetland regulations. The only housing impacts considered here are therefore maintenance-related (infilling for yard expansion and/or dumping of yard waste].
1.2	Commercial & industrial areas						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1.3	Tourism & recreation areas	D	Low	Small (1-10%)	Serious - Slight (1-70%)	High - Moderate	Many subpopulations have some housing development on properties bordering aster occurrences (which are generally on Crown land, or are not readily developed because of flooding and wetland regulations). Housing is densest on the Middle River / Little River subpopulation (14 houses over 800m of shoreline; many with lawns to the shore), and the Eel, Portage, Black and Napan Rivers in Miramichi Bay (roughly 200 houses at an average density of about one per 100 m, but most houses well back from the shore). Effects from existing housing development do not appear to have been significant to this point, but some minor losses from the associated recreational activities (docks, boat launches and trails) can be expected on an ongoing basis. The species appears relatively resilient to local habitat disturbance provided suitable substrate and sufficient adjacent populations remain.
2	Agriculture & aquaculture		Negligible	Negligible (<1%)	Slight (1-10%)	Moderate - Low	
2.1	Annual & perennial non-timber crops		Negligible	Negligible (<1%)	Slight (1-10%)	Moderate - Low	Agriculture (hay, some row crops, some dairy or other livestock farming) occurs immediately adjacent to aster occurrences in portions of several Miramichi Bay subpopulations as well as the Jacquet River and Mill Brook subpopulations. No significant effects have been observed, but similar effects to those noted under housing development are possible (dumping, infilling, docks, boat launches and trails).
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture						
3	Energy production & mining						
3.1	Oil & gas drilling						
3.2	Mining & quarrying						
3.3	Renewable energy						
4	Transportation & service corridors	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	Moderate (Possibly in the short term, < 10 yrs)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.1	Roads & railroads	D	Low	Small (1-10%)	Moderate - Slight (1-30%)	Moderate (Possibly in the short term, < 10 yrs)	Roads, bridges and causeways extending up to or through aster habitat are known at Jacquet River, Beresford, Teagues Brook, Middle/Little River, Napan River, Black River (Black River and Little Black River sites), Bay du Vin River, and Mill Brook in the Richibucto River subpopulation. Similar structures are present near the aster at several other sites. Active railroads cut through the estuaries of Escuminac River, Charlo River and Jacquet River within a few hundred metres of Annual Saltmarsh Aster occurrences and may have eliminated some aster habitat by restricting tidal flow on their landward sides. All of these corridors were constructed well before the ten year period relevant for status assessment, and ongoing impacts do not appear to be substantial. Future maintenance or improvement efforts (i.e. protecting existing bridge footings with rock or cement, or building entirely new footings for bridge replacement, which often involves construction of temporary crossings adjacent to existing ones) could have effects on habitat. There are seven occurrences where small numbers of the aster have colonized the artificial or semi-natural shores of causeways or bridge abutments (Beresford, Little River, Little Black River, Black River, Bay du Vin River), further suggesting that direct habitat impacts from road construction are not a major threat if a good number of plants remain nearby but outside the area of impact.
4.2	Utility & service lines						
4.3	Shipping lanes						
4.4	Flight paths						
5	Biological resource use						
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.1	Recreational activities		Negligible	Negligible (<1%)	Slight (1-10%)	High - Moderate	Minor habitat impacts from recreational activities have been observed at Black River (some plants occurred at the margins of a well-used public boat launch), Cape Jourimain National Wildlife Area (several hunting blinds are present on aster-occupied shoreline), and at Beresford (most of the plants occur in an estuarine saltmarsh within the Beresford Beach Municipal Park that has a large parking area for beach use, a boardwalk through the saltmarsh and playgrounds and baseball fields extending to the edge of the saltmarsh). A group of six cottages is present in an old field area fronting on the downstream edge of the Bass River subpopulation and there is potential for expansion of cottage development at that site. All-terrain vehicle use also occurs to some extent on some aster-occupied shores at low tide. None of these activities are believed to be having significant impacts on any subpopulation numbers at present nor are they expected to in the near future.
6.2	War, civil unrest & military exercises						
6.3	Work & other activities						
7	Natural system modifications						
7.1	Fire & fire suppression						
7.2	Dams & water management/use						
7.3	Other ecosystem modifications						
8	Invasive & other problematic species & genes		Negligible	Negligible (<1%)	Unknown	High - Moderate	
8.1	Invasive non-native/alien species		Negligible	Negligible (<1%)	Unknown	Low (Possibly in the long term, >10 yrs)	No significant issues yet observed. European Common Reed, a significant invasive of saltmarshes further south and west, could be a future issue but the substantial natural disturbance regime of aster sites may limit establishment of very dense stands.
8.2	Problematic native species		Negligible	Negligible (<1%)	Unknown	High - Moderate	Heavy White-tailed Deer herbivory noted at Escuminac, QC site in 2016 by Jacques Labrecque, but not 2015 by AC CDC. This represents a very small portion of the total population and is not necessarily a long-term issue. Deer are not at especially high densities within aster range, there is little literature evidence of deer having major effects on herbaceous saltmarsh species and the seed banking potential of Annual Saltmarsh Aster would help it cope with years in which heavy browsing might occur. That said, if heavy grazing continued for a decade or more (the estimated average longevity of seeds in the seed bank) it might have a significant subpopulation impact.
8.3	Introduced genetic material						
9	Pollution						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
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	Volcanoes						
10	Earthquakes/tsunamis						
10	Avalanches/landslides						
11	Climate change & severe weather		Unknown	Large - Small (1-70%)	Unknown	High - Low	
11	Habitat shifting & alteration		Unknown	Large - Small (1-70%)	Unknown	High - Low	No effects yet observed on Annual Saltmarsh Aster, but loss of coastal landforms is already well-documented. Because the Condon's Pond site has such a high number of plants and is already subject to breaching, potential scope is high. Timing is, however, not considered High because for the plants to be substantially affected would require a different type of breaching than has been observed (i.e. one that caused habitat to become unsuitable). Hypothesized future climate change-related negative effects: habitat loss and change from increased sea levels and increased storm frequency and severity resulting in loss and breaching of barrier dunes, estuary salinity increasing beyond ideal levels and saltmarsh habitat eroding away due to increased exposure to wave action. Reasons Annual Saltmarsh Aster may be resilient to these effects: 1) almost all subpopulations have undeveloped natural habitat to the landward side of aster occurrence so that habitat migration may be possible; 2) many sites have extensive linear occurrence providing a gradient of exposure to hypothesized effects; 3) the species is well adapted to natural disturbance and local scale movement; 4) warming climate may favour southern-affiliated species near their northern limits such as Annual Saltmarsh Aster; 5) In some sites, breaching of barrier systems that form freshwater coastal ponds could provide new suitable habitat.
11	Droughts						
11	Temperature extremes						
11	Storms & flooding						

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