COSEWIC
Assessment and Status Report

on the

American Water-willow
Justicia americana

in Canada

THREATENED
2021

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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

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American Water-willow — Provided by author.

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COSEWIC
Assessment Summary

Assessment Summary – April 2021

Common name
American Water-willow

Scientific name
Justicia americana

Status
Threatened

Reason for designation
This aquatic wildflower of lake and river shorelines occurs at 13 sites in southern Ontario and southwestern Quebec. Although still locally numerous, its numbers have declined significantly in the past 10 years, driven by large losses from the Rivière des Mille Îles in Quebec. Declines are mostly attributable to unnaturally severe or prolonged water level fluctuations caused by water level management and climate change. Invasive species such as European Reed and Blue Cattail are likely to contribute to future population declines.

Occurrence
Ontario, Quebec

Status history
COSEWIC Status History: Designated Threatened in April 1984. Status re-examined and confirmed in May 2000 and May 2021.

COSEWIC
Executive Summary

American Water-willow
Justicia americana

Wildlife Species Description and Significance

American Water-willow is a perennial aquatic herb with both prostrate and erect stems that grows to a height of 20 to 100 cm. It forms monospecific colonies by spreading from stolons, with roots produced at the nodes. The bilaterally symmetrical and irregular flowers are borne in long-peduncled spikes that originate at the junction of the upper leaves and the main stem. The flowers are white to pale violet with characteristic purple mottling on the lower petal.

It is the only representative of the family Acanthaceae in Canada.

Distribution

American Water-willow is native to Canada, the United States, and Mexico. Its core range is in the eastern United States. In Canada, the species is confined to southern Ontario and southern Quebec. A total of 13 extant, five historical, and 12 extirpated subpopulations are known from those areas.

Habitat

The species occurs in slightly acidic to alkaline fresh water, in dynamic, fairly open habitats with little competition from other aquatic plants. It grows along the shores of rivers and lakes, in shallow water, on substrates consisting mainly of gravel, sand, or organic matter. It tolerates considerable fluctuation in water levels.

Biology

American Water-willow is a perennial species that can reproduce both sexually and vegetatively. The plants appear to be mostly insect-pollinated. It is currently unclear whether this species is self-fertile or requires cross-pollination. Its sexual mode of reproduction appears to be inefficient in Canada because no seedlings have been observed in the field, unlike in the United States. Propagation of the species occurs mainly vegetatively from stolons, with roots produced on their nodes. These vegetative structures can establish new subpopulations and form new colonies.

Population Sizes and Trends

In 2020, the Canadian population of American Water-willow was estimated at 1,432,595 mature individuals. The best available information suggests a decline of 94.4% in the overall Canadian population over the past 10 years. This decline is almost entirely attributable to losses from the Rivière des Mille-Îles subpopulation, which accounted for 99% of the total Canadian population in 2007. It declined dramatically in 2010 and later stabilized. Various trends have been seen in the other subpopulations (increase, decline, stability). In Canada, although some population stability seems possible in the future, it is unlikely that an increase in the population will be observed unless action is taken to reduce some of the threats to the species.

Threats and Limiting Factors

The main overall threat to American Water-willow is unnaturally severe or prolonged water level fluctuations at certain critical points in the species' life cycle, mainly due to human activity (water level management) and climate change. However, competition for resources with invasive alien species, especially European Reed, has the potential to be a significant threat going forward. Intensive erosion, associated with more severe storms associated with climate change, is also a significant possible threat to the species. Minor threats include browsing by White-tailed Deer, human trampling, and water pollution.

Protection, Status and Ranks

American Water-willow was designated Threatened in Canada in 1984. The species was added to Schedule 1 of the *Species at Risk Act* in 2003. It was designated threatened in Quebec in 1998 under the *Act Respecting Threatened or Vulnerable Species*; it was also designated threatened in Ontario in 2008 under the *Endangered Species Act*.

In Canada, the species is considered to be at a high to moderate risk of extirpation (national rank of N2N3), whereas at the subnational level, the risk is considered high (S2 in Ontario and Quebec).

The species occurs mainly on provincially or federally owned land and several subpopulations are within protected areas. In all, 9 extant subpopulations are within protected areas, including a federal national park, provincial parks and Plant Habitats (protected areas) in Quebec. In addition, the new Saint-Michel-de-Bellechasse subpopulation will be included in a Plant Habitat protected area.

TECHNICAL SUMMARY

Justicia americana

American Water-willow

Carmantine d'Amérique

Range of occurrence in Canada:Ontario and Quebec

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)	Unknown, perhaps at least 10-15 years. This is a clonal species that can persist a long time in the same location.
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes. Observed decline of 94.4% over past decade (mostly from 2007 to 2014) and projected continuing decline due to impact of threats.
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations].	Decline of 48% over 2 generations (since previous status report, 2000) but likely higher as largest subpopulation counts were not considered complete at earlier measurements (1994-1995).
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Decline over past three generations (30-45 years) likely > 50%, with 48% decline since 1994-95.
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Suspected reduction of > 10% due to ongoing threats. Threat calculator impact predicts 10-100% decline over three generations.
[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.	Observed and expected decline of > 50% over three generations (30-45 years) including past and future as decline of 94% since recovery strategy estimates (mostly 2007-2008) and suspected future decline of at least 10%
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. No b. No, partial understanding c. No
Are there extreme fluctuations in number of mature individuals?	No. Fluctuation in stem counts observed but underground stolons may be intact, so total population is not undergoing extreme fluctuations.

Extent and Area Information

Estimated extent of occurrence	53 241 km^2
Index of area of occupancy (IAO) (Always report 2x2 grid value)	228 km²

Is the population “severely fragmented” i.e. >50% of its total area of occupancy is in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of “locations”* (use plausible range to reflect uncertainty if appropriate).	11+
Is there an observed, inferred, or projected decline in extent of occurrence?	Yes, observed (slight) decline relative to the former extent of occurrence
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy?	Yes, observed, mainly because of the Rivière des Mille-Îles subpopulation.
Is there an [observed, inferred, or projected] continuing decline in number of populations?	Inferred, as no plants seen at 2 extant subpopulations during the last visit (Île Bélair, Sharbot Lake); ephemeral subpopulations appear to be a characteristic of this species.
Is there an [observed, inferred, or projected] decline in number of locations*?	Possibly as no plants seen at 2 extant locations during the last visit (Île Bélair, Sharbot Lake); some sites appear to be ephemeral and do not become established subpopulations.
Is there an [observed, inferred, or projected] decline in [area, extent, and/or quality] of the habitat?	Yes, observed (slight) decline, for the three parameters.
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)

Subpopulation (only the extant subpopulations are indicated)	**Number of mature individuals ([stems] see Abundance) (last year of survey)**
2. Point Pelee National Park	11,420 (2014)
10. Welland River/Lyon’s Creek	108,691 (2018)
11. Dufferin Island	19,520 (2018)
12. Pelee Island - South shore	150 (2007)
13. Hill Island	59,007 (2008)
14. Grenadier Island	3,600 (2008)
15. Marina of Leamington	18 (2018)
16. Sharbot Lake	0 (2018 not observed; previous survey: number of stems unknown)

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

18. Rivière des Mille-Îles	1,176,101 (2017, 2018, and 2020)
19. Godefroy River	705 (2018)
24. Île Rock	53,376 (2017)
29. Île Bélair	0 (not observed; previous survey: number of stems unknown)
30. Saint-Michel-de-Bellechasse	7 (2018)
Total	**1,432,595**

Quantitative Analysis

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

Threats (actual or imminent, to populations or habitats, from highest impact to least)

Was a threats calculator completed for this species? Yes, on 14 November 2019.
The calculated and assigned threats impact is Very High to High.

i. Invasive alien species (Very High – High impact)
ii. Dams and water management/ use (Medium – Low)
iii. Climate change (Medium – Low impact)
iv. Recreational activities (Low impact)
v. Housing & Urban areas (Low impact)

What additional limiting factors are relevant?
Low genetic diversity, northern limit of range, dynamic site conditions.

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada	States most likely to provide immigrants: Michigan, S2; New York, S4; Pennsylvania, S5; Ohio SNR; Vermont, SX.
Is immigration known or possible?	Immigration possible, particularly from northern New York into Thousand Islands region, Ontario
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes (a large amount of potential habitat is unoccupied)
Are conditions deteriorating in Canada?	Possibly, but not significantly
Are conditions for the source population deteriorating? [+]	Unknown
Is the Canadian population considered to be a sink?	No
Is rescue from outside populations likely?	No. Immigration possible, from northern New York into Thousand Islands region, Ontario, but of an unknown amount

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

Data Sensitive Species

Is this a data sensitive species?	No

Status History

COSEWIC Status History: Designated Threatened in April 1984. Status re-examined and confirmed in May 2000 and May 2021.

Recommended Status and Reasons for Designation

Recommended status: Threatened	**Alpha-numeric code:** A2ace+4ace
Reasons for Designation: This aquatic wildflower of lake and river shorelines occurs at 13 sites in southern Ontario and southwestern Quebec. Although still locally numerous, its numbers have declined significantly in the past 10 years, driven by large losses from the Rivière des Mille Îles in Quebec. Declines are mostly attributable to unnaturally severe or prolonged water level fluctuations caused by water level management and climate change. Invasive species such as European Reed and Blue Cattail are likely to contribute to future population declines.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets Threatened, A2 due to (a) observed decline in number of mature individuals of over 30% in the last three generations with (c) declines in index of area of occupancy, extent of occurrence and habitat quality, partly as a result of (e) introduced invasive species; and A4 due to observed and predicted declines of over 30% in three generations that include both the past and future. Although observed declines in mature individuals is over 90 percent, it is challenging to accurately count mature individuals under some conditions, e.g., low water years, and as a clonal plant where stems are counted or estimated as mature individuals, there is uncertainty in the data.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Although the IAO is well below the threshold of 2,000 km^2 for Threatened B2, and there are observed and/or projected declines in extent and quality of habitat and number of mature individuals, there are greater than 10 locations, the population is not severely fragmented, and it does not undergo extreme fluctuations.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Does not meet criteria as number of mature individuals exceeds thresholds.
Criterion D (Very Small or Restricted Population): Not applicable. Does not meet criteria as number of mature individuals exceeds thresholds.
Criterion E (Quantitative Analysis): Not applicable. Not assessed.

PREFACE

Since the last assessment, the American Water-willow population in Canada has declined overall, although individual subpopulations have declined, increased, or remained stable. New subpopulations were discovered around Thousand Islands National Park (2008), Sharbot Lake (2012), Saint-Michel-de-Bellechasse (2015) and around Rivière des Mille-Îles (2020). Some historical subpopulations could not be relocated, and Sharbot Lake is now considered extirpated.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS (2021)

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

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

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

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

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

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

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Scientific Name: *Justicia americana* (Linnaeus) Vahl

Pertinent Synonym: *Dianthera americana* Linnaeus, *Dicliptera americana* (Linnaeus) Alp. Wood

English Name: American Water-willow

French Name: Carmantine d'Amérique

Family Name: Acanthaceae

Major Plant Group: Angiosperm, Dicot

Morphological Description

American Water-willow (see cover photo) is a perennial aquatic herb with both prostrate and erect stems that grows to a height of 20 to 100 cm. The plant forms monospecific colonies by spreading from stolons, with roots produced at the nodes. The leaves are entire, linear to narrowly lanceolate or narrowly oblong, 8 to 16 cm long and 0.5 to 1.5 cm wide. They occur in opposite pairs along the stem. The bilaterally symmetrical and irregular flowers are borne in long-peduncled spikes that originate at the junction of the upper leaves and the main stem. The flowers are white to pale violet with characteristic purple mottling on the lower petal. The fruit is a capsule containing 2 to 4 warty-rugose seeds each measuring 3 mm (Gleason and Cronquist 1963; Jolicoeur and Couillard 2007).

Population Spatial Structure and Variability

In Canada, there are 13 extant subpopulations, 5 historical subpopulations and 12 extirpated subpopulations of American Water-willow, according to the criteria developed by NatureServe (2002) and adopted by the CDPNQ (Centre de données sur le patrimoine naturel du Québec) and the NHIC (Natural Heritage Information Centre) (Table 1). Even considering historical and extirpated subpopulations, the subpopulations are generally isolated from one another, which limits the possibility of genetic exchange between them. The distance between the closest extant subpopulations ranges from 2 km (Dufferin Island and Welland River/Lyon's Creek) to over 284 km (Grenadier Island and Dufferin Island). A large portion of potential habitat appears not to be occupied.

Table 1. Synthesis of quantitative and qualitative data on American Water-willow subpopulations in Canada.

Subpopulation	Name of Site	Province	Number of individuals (most recent visit)	Previous records	Area of occupancy (most recent visit)	Last visit	Last observation	Last observation observer	Trend	Official status
1	Pelee Island - Lighthouse point	Ontario	0	A few stems	0	2007	1988	Allen Woodliffe		Extirpated
2	Point Pelee National Park	Ontario	11,420 (partial)	Lake pond: 19,702 stems (2013); 30,042 stems (2007); 200,000 stems (1999); 200,000 stems (1983). The Redhead Pond colony disappeared in the 2007 survey: 2,000 stems (1999); 1,000 stems (1984)	148 m^2	2014	2014	Parks Canada	decline	extant
3	Pelee Island - Fish point	Ontario	0	A few stems	0	2007	1984	Allen Woodliffe		extirpated
4	Rondeau Peninsula and Harbour Wetlands	Ontario	0	last obs. 1984: 30 plants	0	2010	1984	Allen Woodliffe	presumed extant	historical
5	Delhi	Ontario	0	unknown	0	unknown	1954	Unknown		extirpated
6	Long Point National Wildlife Area	Ontario	0	unknown	0	2009	1978	Environment Canada	presumed extant	historical
7	East of Kingsville	Ontario	0	unknown	0	unknown	1891	unknown		extirpated
8	Middle Island	Ontario	0	unknown	0	2007	1982	R.L. Stuckey & K. Duncan		extirpated
9	Port Burwell Prov. Park	Ontario	0	1 dense colony (1989)	0	2016	1989	Mike Oldham	extirpation	historical
10	Welland River/Lyon's Creek (portion Welland)	Ontario	3,236	6,000 stems (2016) but possible overlap with adjacent portion of Lyon's Creek	55 m^2	2018	2018	Land Care Niagara	unknown	extant

Subpopulation	Name of Site	Province	Number of individuals (most recent visit)	Previous records	Area of occupancy (most recent visit)	Last visit	Last observation	Last observation observer	Trend	Official status
10	Welland River/Lyon's Creek (portion Lyon's)	Ontario	105,455	101,541 stems (2017); 69,300 stems (2016); 2,855 stems upstream of Stanley Avenue (2015); 3,235 stems upstream of Stanley Avenue (2014); 12,568 stems (2013)	2,753 m^2	2018	2018	Land Care Niagara	growing	extant
11	Dufferin Island	Ontario	19,520 (2017 survey)	6,880 stems (2015); 3,000 stems (2013)	244 m^2 (2017 survey)	2018	2018	Land Care Niagara	growing	extant
12	Pelee Island - South shore	Ontario	150	none	1 m^2	2007	2007	S. Brinker and M. Celestino	unknown	extant
13	Hill Island	Ontario	59,007	none	500 m^2	2014	2008	S. Thompson	unknown	extant
14	Grenadier Island	Ontario	3,600	none	120 m^2	2008	2008	S. Thompson	unknown	extant
15	Marina of Leamington	Ontario	18	1 clone covering 2 m^2 (2011); 86 stems in 1 clone (2010); 1 clone covering 1.4 m^2 (2009)	2 m^2	2018	2018	Tammy Dobbie	maintenance	extant
16	Sharbot Lake	Ontario	0	unknown	0	2018	2012	unknown	extirpation	extant
17	Île Ronde	Quebec	0	unknown (large population according to Jolicoeur and Couillard (2007))	0	unknown	1951	unknown		extirpated
18	Rivière des Mille-Îles (western and central)	Quebec	1,171,920 (2014 survey)	See Table 2	19,530.72 m^2 (2014 survey)	2017	2017	Éco Nature	decline	extant
18	Rivière des Mille-Îles (eastern)	Quebec	4,181	10,261 stems (2007)	136 m^2	2020	2018 and 2020	Éco Nature (2018)- Bureau d'écologie appliquée (2020)	decline	extant

Subpopulation	Name of Site	Province	Number of individuals (most recent visit)	Previous records	Area of occupancy (most recent visit)	Last visit	Last observation	Last observation observer	Trend	Official status
19	Godefroy River	Quebec	705	6,201.63 m^2 (2014) but no abundance estimate; 25,000 stems (1994)	30 m^2	2018	2018	Bureau d'écologie appliquée	decline	extant
20	Kahnawake	Quebec	0	unknown	0	unknown	1940	unknown		extirpated
21	Île aux Cochons	Quebec	0	unknown	0	unknown	1967	unknown		extirpated
22	Île Plate (Île Verte)	Quebec	0	unknown	0	unknown	1934	unknown		extirpated
23	Saint-Lambert	Quebec	0	unknown	0	unknown	1950	unknown		extirpated
24	Île Rock	Quebec	53,376	70,000 stems (2007); 3,000 stems (1998); 1,000 stems (1977); 848 stems (1976)	493.5 m^2	2017	2017	Héritage Laurentien	maintenance	extant
25	Île Jésus, Rivière des Prairies	Quebec	0	unknown	0	2018	1972	unknown	extirpation	historical
26	Brosseau	Quebec	0	stems	0	stems	1948	unknown		extirpated
27	Île des Soeurs	Quebec	0	unknown	0	unknown	1964	unknown		extirpated
28	Longueuil	Quebec	0	unknown	0	2018	1952	unknown	extirpation	historical
29	Île Bélair	Quebec	0	unknown	0	2018	2009	unknown	extirpation	extant
30	Saint-Michel-de-Bellechasse	Quebec	7	5 stems (2015)	1 m^2	2018	2018	Bureau d'écologie appliquée	maintenance	extant

Table 2. Recent quantitative demographic data for the western and central portions of the Rivière des Mille-Îles American Water-willow subpopulation.

Year	Total area (m^2)	Number of stems
2004	33 761.7	24,747,326
2005	28 421.1	20,832,666
2006	33 464.5	24,529,478
2007	34 548.1	25,323,757
2009	26 769.7	
2010	4 566 (incomplete)	
2011	19 883.1	614,156
2012	16 070.64	

Year	Total area (m^2)	Number of stems
2013	19 653.39	
2014	19 530.72	1,171,920

Note 1: the total area, expressed in square metres, as well as the number of stems, corresponds solely to the western and central portion of the Rivière des Mille-Îles subpopulation. This is nonetheless the largest part of the subpopulation.

Note 2: The estimated number of stems, where available, was calculated by multiplying the area of delineated colonies by a typical density measured in the field, and then adding a count of plants and small isolated colonies. For the years 2004 to 2007, the typical density came from the 2004 survey (733 stems per square metre). For 2011 and 2014, the density used came from calculations made during the year.

Note 3: The number of stems was not calculated by Éco-Nature observers for 2009, 2010, 2012, and 2013.

Note 4: The 2010 survey is incomplete because the water level (high water) during surveys prevented the conduct of exhaustive surveys. Nonetheless, the qualitative observations from 2010, confirmed by the exhaustive surveys of 2011, showed a drastic decline in the subpopulation relative to the 2009 level.

Note 5: The number of stems reported for this subpopulation in 1994 was 225,000 and for 1995 was 2,500,000 (White 2000) but these are considered underestimates (Labrecque pers. comm. 2021).

American Water-willow is at the northern limit of its range in Canada (Parks Canada Agency 2011). Species at the northern edge of their range generally have smaller populations (Nantel and Gagnon 1999) and are therefore more susceptible to founder effects, genetic drift, and introgression—all factors that contribute to a reduction of genetic diversity (Maslovat 2009).

The Dufferin Island and Welland River/Lyon's Creek colonies are considered distinct subpopulations despite the short distance between them (about 2 km) because it is unlikely that seeds or plant fragments can move between the Dufferin Island subpopulation and the Niagara River, from which it is physically separated by water management facilities.

American Water-willow is known for its extensive vegetative propagation, which in some cases has led to it being considered invasive and undesirable in the United States (Penfound 1940; Couch 1976). While little is known about its sexual reproduction (OMNR 2013), sexual reproduction can apparently play a significant role in the propagation of the plant, particularly in its core range (Penfound 1940). In Canada, seed viability was tested for two distinct subpopulations: the Welland River/Lyon's Creek subpopulation and the Rivière des Mille-Îles subpopulation. In both cases, the germination rate was zero (Bisson *et al.* 2003; L. Vasseur pers. comm. 2019). Field observations suggest that vegetative propagation accounts for most, if not all, propagation in Canada (Deshaies pers. obs.; Lachance pers. obs.; Groff pers. comm. 2018; Poulin pers. comm. 2018). Limited sexual reproduction in Canada, would significantly constrain the genetic diversity of the species.

The geographic isolation of the various subpopulations could also result in low genetic diversity. That possibility is being investigated by Liette Vasseur, Brock University (Groff pers. obs. 2018) using specimens from the following subpopulations: Rivière des Mille-Îles, Welland River/Lyon's Creek, and Point Pelee National Park.

Designatable Units

In Canada, the total population of American Water-willow is included in the Great Lakes Plains ecological area, as defined by COSEWIC (2015). Furthermore, there are no subspecies or varieties of American Water-willow (Brouillet *et al.* 2010+; USDA 2018). Because the ecology and habitat of all the Canadian subpopulations are similar, and there is no evidence of discreteness or evolutionary significance between one or more subpopulations, it is appropriate to consider the Canadian population as a single designatable unit.

Significance

In Canada, American Water-willow is at the northern limit of its range. It is the only representative of the family Acanthaceae in Canada. Less than 5% of the species' total population is in Canada (Parks Canada Agency 2011). In a changing climate, the Canadian population of American Water-willow is of some importance, because if the climate becomes milder in Canada, it could extend its range in Ontario and Quebec. The important role that Canada can play as a climate refuge in the context of climate change has been mentioned, including the potential northward migration of predominantly southern taxa like American Water-willow (Berteaux *et al.* 2018; Gendreau *et al.* 2018). Subpopulations at the northern limit of a species' range are generally smaller than central subpopulations (Nantel and Gagnon 1999), however, and are thus more likely to have low genetic diversity (Leimu *et al.* 2006), which could make them less able to adapt to coming global changes. In addition, populations at the northern limit of their range can have lower and more variable growth rates, making them more vulnerable to potential stochastic events or more drastic global changes (Nantel and Gagnon 1999).

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

DISTRIBUTION

Global Range

Globally, American Water-willow ranges from Canada to Mexico (Figure 1). In the United States, the species ranges from Wisconsin to Vermont in the north to Texas and Florida in the south. The species' core range and its core abundance is in the U.S. Midwest (Missouri, Illinois, Indiana, etc.) and in the southern Appalachians (Kentucky, Virginia, West Virginia, etc.) (Kartesz 2015). American Water-willow is a southern peripheral species in Mexico and it is relatively uncommon, being known only from the states of Chihuahua and Coahuila (Villaseñor 2016).

Figure 1. North American range (excluding Mexico) of American Water-willow. (Source: MELCC 2019.)

Canadian Range

In Canada, American Water-willow is restricted to Canadian regions with mild climatic conditions (Figure 2). It occurs exclusively in the Great Lakes Plains ecological area (COSEWIC 2015), and more specifically, from extreme southwestern Ontario (Lake Erie) to the far end of the upper St. Lawrence estuary (around Île d'Orléans, Quebec). In this major water corridor, which straddles southern Ontario and Quebec, American Water-willow has 13 extant subpopulations, 5 historical subpopulations, and 12 extirpated subpopulations[1].

[1] From the perspective of both the CDPNQ and the NHIC, a element occurrence is considered historical when it has not been observed for more than 20 years, regardless of whether the site has been visited in the interim (Tardif *et al.* 2016; Hammerson *et al*. 2008).

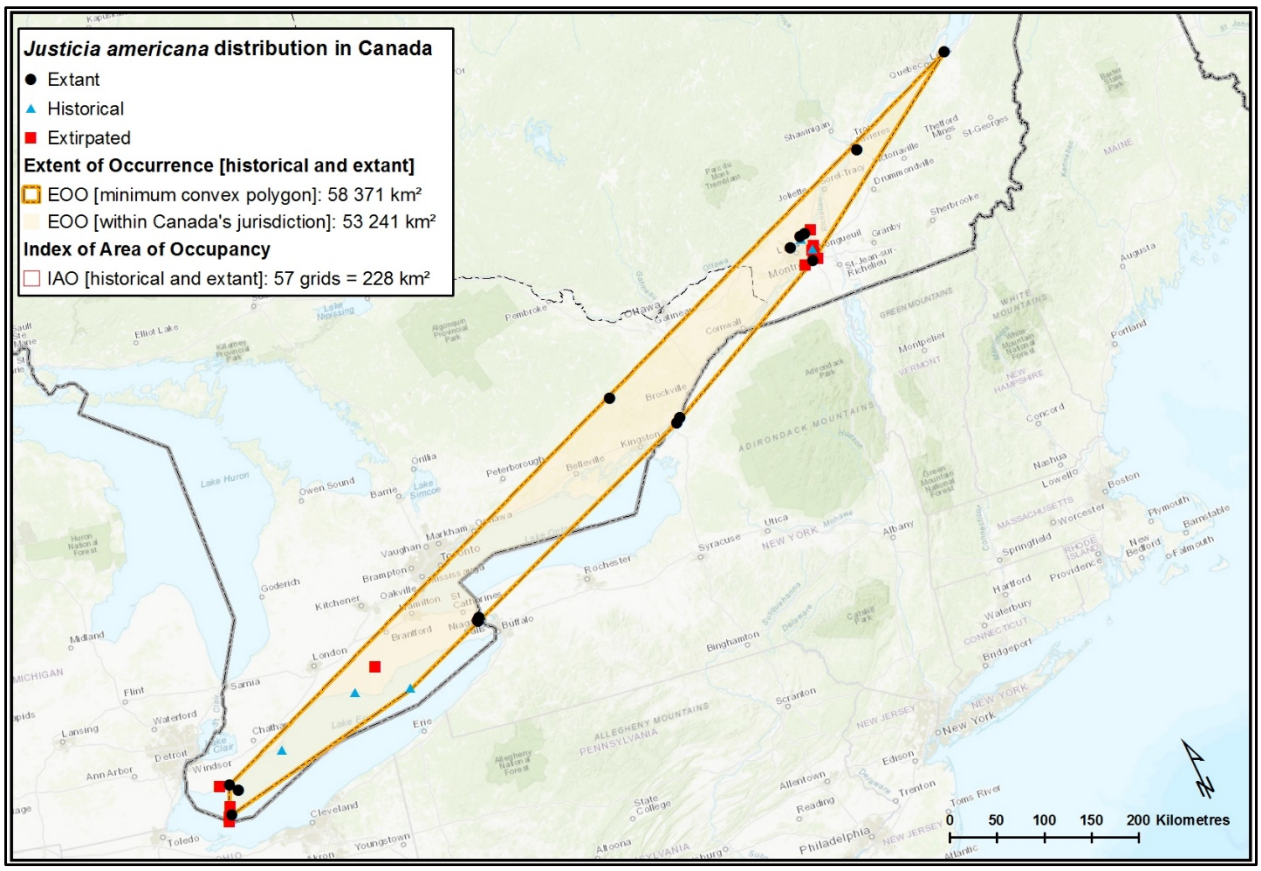

Figure 2. Distribution of American Water-willow in Canada.

The Canadian subpopulations are generally widely spaced (several kilometres to hundreds of kilometres) (Figure 2). Furthermore, despite the continuity of the hydrological environment between Lake Erie, Lake Ontario, and the St. Lawrence River, as a result of navigation and hydro power developments, areas of potential habitat are widely dispersed. Lastly, the shores of Lake Erie, Lake Ontario, and the St. Lawrence River are heavily altered in some areas, which limits potential American Water-willow colonization.

From a historical perspective, the Canadian distribution of American Water-willow appears to have changed little. Among the recent additions to the species' known distribution, the small (single clone) Saint-Michel-de-Bellechasse subpopulation (discovered in 2015) is unusual for its location in the upper St. Lawrence estuary. This is an area with significant daily tides (Fisheries and Oceans Canada 2019), which is atypical for the species' habitat. However, American Water-willow can tolerate large fluctuations in water level (Fritz *et al.* 2004a; Strakosh *et al.* 2005; Jolicoeur and Couillard 2007) but there are contradictory findings concerning the effects on the health of the colonies and these effects are poorly understood (Parks Canada Agency 2011). The Saint-Michel-de-Bellechasse subpopulation, located 180 km northeast of the closest subpopulation (Godefroy River), is also isolated. In the Thousand Islands region of the St. Lawrence River, Ontario, the species was not known to occur until being found around Grenadier Island and Hill Island

(2008). The recently discovered (2012) Sharbot Lake subpopulation is not directly connected to the St. Lawrence River (although it is in the St. Lawrence River watershed).

All but one of the historical and extirpated Ontario subpopulations are located along the shores of Lake Erie and some of its islands. All the historical and extirpated subpopulations in Quebec are located in the Montréal area. Infilling associated with urban development and dredging of the St. Lawrence Seaway are believed to have contributed to the extirpation of these subpopulations (Jolicoeur and Couillard 2007).

Extent of Occurrence and Area of Occupancy

Following COSEWIC guidelines (2015), the extent of occurrence in Canada, measured using a convex polygon around extant and historical subpopulations is 53 241 km^2.

The index of area of occupancy (IAO) in Canada for the extant and historical subpopulations, derived using a 2 km x 2 km grid, is 228 km^2. The total actual area of occupancy is estimated to be 0.02 km^2.

Search Effort

American Water-willow has always been considered rare in Canada (Parks Canada Agency 2011). The species was first reported by André Michaux, in 1792 from Laprairie, Quebec (Marie-Victorin 1929 in Rousseau 1974). Rousseau (1974) considered the species to be restricted to the Hochelaga Archipelago, which comprises more than 300 islands and islets at the confluence of the St. Lawrence and Ottawa rivers (NCC 2019). The archipelago includes the islands and islets on the Rivière des Mille-Îles, the Rivière des Prairies, and the portion of the St. Lawrence around the Island of Montréal (NCC 2019). The oldest record for the Godefroy River subpopulation is from 1973 (Canadensys 2019). Given the species' colony-forming nature, its large stature and its interesting flowering habit, it is unlikely that botanists in the 20th century would have failed to find and record colonies, at least not in the Montréal region. Its potential propagation via stem and rhizome fragments (Strakosh *et al.* 2005; Collingsworth *et al.* 2007; Touchette *et al.* 2011) and the discovery of the Saint-Michel-de-Bellechasse subpopulation, however, suggest other colonies likely occur (or once occurred) along the St. Lawrence River. However, in these regions, the St. Lawrence shoreline is a highly dynamic environment that is subject to both intra-annual and interannual variability, which could mean that most of these pioneer colonies are ephemeral. This hypothesis was advanced to explain the sudden disappearance of certain subpopulations in Ontario (White 2000). Strakosh *et al.* (2005) and Touchette *et al.* (2011) reported high mortality under certain environmental conditions, e.g., flooding, following transplantation.

In Ontario, the first record of American Water-willow dates from 1879 (Dufferin Island subpopulation) followed by an 1891 record at Kingsville, on the shores of Lake Erie (NHIC 2018). The latter subpopulation is now considered extirpated. Most observations of American Water-willow in Ontario are located within or near national (Point Pelee National

Park, Thousand Islands National Park) or provincial (Port Burwell Provincial Park, Rondeau Provincial Park) parks, or in marinas (Leamington). These are areas of moderate to high human use, which are often visited by botanists (except for the marina), which increases the likelihood that American Water-willow would be observed.

During the preparation of this status report, the report writers carried out field surveys and made requests for data to collaborators with the objective of updating the information on known subpopulations of the species, primarily extant and historical subpopulations (Table 1). The field surveys did not include the extirpated subpopulations.

All the subpopulations (extant, historical, and extirpated) are accounted for in the distribution maps (Figure 2).

HABITAT

Habitat Requirements

Parks Canada Agency (2011) indicates that American Water-willow requires a dynamic and fairly open habitat offering little or no competition from other aquatic plant species (Rousseau 1974; Varga 1984; Strakosh *et al*. 2005). It grows along rivers, in the St. Lawrence estuary, and along the shores of shallow lakes on a substrate of gravel, sand, or organic material. The species may also grow on floating peat mats, in cattail (*Typha* spp.) marshes (Brinker 2007 in Parks Canada Agency 2011) or on clayey or rocky substrates (Jolicoeur and Couillard 2007). American Water-willow can survive in water up to 1.2 m deep (Penfound 1940) and tolerates droughts and periods of little or no water cover, provided the soil remains wet (Jolicoeur and Couillard 2007). The species' roots always remain below the ground water (Varga 1984 in Parks Canada Agency 2011). American Water-willow is tolerant of moderate water level fluctuations and high turbidity levels (Niering and Olmstead 1997; Dick *et al.* 2004; Smart *et al.* 2005). The species is known to inhabit fresh water (Parks Canada Agency 2011; USDA 2019).

Before the Saint-Michel-de-Bellechasse subpopulation was discovered in the easternmost part of the upper St. Lawrence estuary, no subpopulation had been found in that part of St. Lawrence River in Canada (Working Group on the State of the St. Lawrence Monitoring 2014). The actual salinity to which it is exposed should be measured to assess the true significance of this subpopulation. American Water-willow cannot survive in a pH of 5.5 or lower (Koryak and Reilly 1984; Adams *et al*. 1973 in Parks Canada Agency 2011). Furthermore, hard water and an abundance of organic material promote the growth of American Water-willow (Hill 1981; Howell 1975 in Parks Canada Agency 2011).

Habitat Trends

During the 20th century, American Water-willow habitat was subject to heavy development pressure, which has led to significant habitat loss. Infilling and urban development were the main pressures, along with the construction of the St. Lawrence Seaway, and the development of major human infrastructure in the Niagara region and

other areas (Jolicoeur and Couillard 2007). At least a quarter of subpopulations are now isolated by hundreds of kilometres of human infrastructure (dams, roads, etc.). In recent decades, there has been relatively little real habitat loss from human activity. The banks and shorelines of the Great Lakes and the St. Lawrence River are increasingly included in protected areas and stricter laws govern their use. Recent habitat losses have largely occurred on banks and, to a lesser extent, in littoral areas, mainly due to invasion by exotic species.

BIOLOGY

Life Cycle and Reproduction

Little is known about the life cycle and reproduction of American Water-willow. Penfound (1940) reported that sexual reproduction may play a key role in the plant's propagation in Tennessee, but few recent indicators or observations provide confirmation of this in Canada. In some subpopulations, an abundance of fruit was noted (Jolicoeur and Couillard 2007), whereas it is absent in others (MacPhail 2013 in MacPhail 2015).

Pollination is carried out by several large insect groups, including bumblebees and syrphid flies (MacPhail 2015). It is unclear, however, whether the species is self-fertile or requires cross-pollination. The seed germination rate in natural populations is not known. Sexual reproduction is probably not what enables the colonies of this plant to thrive and spread. It typically develops from a dense network of stolons and rhizomes (Jolicoeur and Couillard 2007), which can be anchored deep in the substrate, thus improving stability and retention (Fritz *et al.* 2004a). In addition, stem or stolon fragments can drift along rivers and become established when they are deposited on the shoreline (Penfound 1940).

In Canada, American Water-willow flowers from July to mid-September (Comité flore québécoise de FloraQuebeca 2009). It takes at least one year to produce a flowering plant from a seed (Penfound 1940). Because this species is the only representative of the genus within its Canadian range, hybridization potential is nil.

Physiology and Adaptability

Because American Water-willow is a perennial species that reproduces mainly vegetatively, it is likely that the genetic diversity found within Canadian populations is low, reducing its capacity to adapt to environmental changes and stresses (White 2000). Despite the attendant effects on its habitat of water level fluctuations, the species can survive and reproduce. Its flexible stems with well-developed fibro-vascular and aerenchymatous systems are resistant to flooding and significant water level fluctuations (Penfound 1940). The plant's deep rhizomes enable it to access water at all times, even during drought conditions (Jolicoeur and Couillard 2007). On the other hand, Touchette *et al.* (2008) found in greenhouse experiments that American Water-willow was sensitive to drought conditions "as indicated by complete mortality for all drought treated plants after 3 weeks of water stress". During the growing season, the plant seems more vulnerable to

floods or unusually high water levels and to a lack of light as well as drought (Fritz *et al.* 2004a; Strakosh *et al.* 2005). Spring flooding has little influence on the species because it is dormant at that time (Haslam 1978 in Strakosh *et al.* 2005). During the growing season, however, the plant may not have sufficient light to ensure its reproduction and survival if flooding is extreme and long-lasting. Controlled experiments provide evidence supporting this hypothesis because the amount of available light has a positive effect on the plant's total biomass (Fritz *et al.* 2004a).

Survival rates are higher under desiccation conditions than inundation (Strakosh *et al.* 2005). Another interesting adaptation of the species' vegetative reproduction relates to the transfer that occurs between the mother plant and clones during periods of drought. During the expansion of a colony, the mother plant helps provide nutrients essential for its clones (Touchette *et al.* 2011). A clone that is exposed to drought sends a signal to the mother plant indicating that the colony should use adaptive mechanisms (e.g., succulent leaves) to handle the upcoming harsh conditions.

No germination was obtained in tests conducted on a limited number of seeds from the Rivière des Mille-Îles subpopulation (Bisson *et al.* 2003) and the Welland River/Lyon's Creek subpopulation (L. Vasseur pers. obs. 2019). The report writers nonetheless suggest the possibility that the methodology used to stimulate germination in these initial tests was not optimal (Bisson *et al.* 2003; L. Vasseur pers. obs. 2019). In contrast, vegetative reproduction has been achieved in experiments undertaken to propagate the species from stem fragments; the harvested fragments eventually produced stems and leaves under suitable growing conditions (Strakosh *et al.* 2005; Collingsworth *et al.* 2007; Touchette *et al.* 2011). It appears that growing the plants on a flooded rather than saturated substrate provides better propagation results in a controlled environment (Touchette *et al.* 2011). Furthermore, considering the species' hydrologically dynamic environment, it is best to wait until the stem fragments have a developing root system before transplanting them (Collingsworth *et al.* 2007). According to this study, the first signs of root development were noted on day 11 in the controlled environment; in the natural environment, root development begins after about a month. In a trial carried out in the natural environment where the Rivière des Mille-Îles subpopulation is located, stolon fragments were planted directly in suitable habitat, but did not successfully regenerate (Bisson *et al.* 2003).

Dispersal and Migration

Dispersal of American Water-willow is highly dependent on currents, flooding, erosion, and natural stream dynamics. The species may also benefit from human-induced dispersal by boats and other watercraft (Penfound 1940; Jolicoeur and Couillard 2007) as has been observed for ephemeral subpopulations like Saint-Michel-de-Bellechasse and Sharbot Lake. Seeds can stay afloat for at least an hour. They can also be submersed for up to two days and still germinate. The species can also potentially disperse long distances through fruit capsules, seeds, and seedlings (Penfound 1940). However, germination rate and sexual reproductive success are not well documented in Canada. The primary mechanism by which American Water-willow can extend its range is the dispersal of stem and stolon fragments by currents.

Interspecific Interactions

American Water-willow does not appear to be dependent on other species for its survival. The species provides a refuge for a variety of species such as mussels and other benthic invertebrates by helping to stabilize the environment (Fritz *et al.* 2004b); it also adds to habitat heterogeneity in streambeds (Koryak and Reilly 1984). Strakosh *et al.* (2009) and Stahr and Shoup (2015) describe interactions with juvenile Largemouth Bass, *Micropterus salmoides*. Groff (2019) reports that Ontario subpopulations are host to a species of Dodder (*Cuscuta*), a parasitic plant, which is thought to inhibit growth and development of its host. The density of root parasites affects stem density at the end of the growing season, but not total biomass (Fritz *et al.* 2004b). Some subpopulations are affected by herbivores, primarily White-tailed Deer (*Odocoileus virginianus*), which browse on the stems of the plant (Jolicoeur and Couillard 2007).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

In Canada, there are 13 extant subpopulations, 5 historical subpopulations, and 12 extirpated subpopulations of American Water-willow (Table 1). Since the publication of the update status report on American Water-willow in Canada (White 2000), all extant and historical subpopulations have been examined in surveys aimed at estimating their size and extent. None of the sites of extirpated subpopulations, however, has been searched since 2000.

In 2018, a precise count of stems was performed in subpopulations characterized by low to medium colony density. In high density colonies, relative density was calculated on the basis of quadrats representative of the observed density, and the total number of stems was extrapolated from the area of the colony and its calculated density. In general, as soon as a colony or an isolated specimen of American Water-willow was noted, a GPS waypoint was taken. The exceptions to this rule include the subpopulations of Île Rock, Dufferin Island, a section of the Rivière des Mille-Îles (between Barrage des Moulins and the mouth of the Mascouche River) and Welland River/Lyon's Creek. In the case of Île Rock (Di Fiore 2020) and Dufferin Island (Groff pers. obs. 2019), the colony boundaries were precisely delineated in the field using GPS. For the Welland River/Lyon's Creek subpopulation, the area of the most extensive colonies was measured using a visual equivalent of area (a canoe = about 5 m x 1 m) and a GPS waypoint was usually taken to mark the start and end of the colony in question (Groff pers. obs. 2019). For the above-mentioned segment of the Rivière des Mille-Îles subpopulation, during the monitoring period from 2004 to 2007, all the colonies were delineated using GPS but only colonies larger than 6 m^2 were included in the total area, which nonetheless accounts for more than 99% of the areas counted (Bisson and Gauvin 2008). From 2009 to 2014, GPS was used to delineate the boundaries of colonies comprising more than 100 stems. A GPS waypoint was taken for the other colonies and for isolated stems (M. Poulin pers. obs. 2018).

For subpopulations visited since the publication of the updated status report (White 2000), the abundance and area data are considered quite accurate, even if in most cases both the abundance and area are estimates. The Hill Island and Grenadier Island subpopulations have not been resampled since 2008, however, which means that the data presented are the same as those published in Parks Canada Agency (2011).

American Water-willow is absent from much of the potential habitat in Canada. Its subpopulations are mostly isolated, but also are connected, in many cases, by large expanses of more or less continuous potential habitat. The historical trends recorded by Rousseau (1974) and White (2000) appear to indicate that the species has always been rare and localized in Canada.

Abundance

The total Canadian population of American Water-willow is estimated at 1,432,595 mature individuals (Table 1). According to COSEWIC (2015), a mature individual is an individual that is capable of reproducing, and this includes individuals (reproductive units) that are part of a given clone. Because the plants can reproduce vegetatively through fragmentation, each stem was considered a mature individual. The number of clones included in the population is much smaller, although the exact number is unknown. It is possible that a single clone may have given rise to distinct subpopulations (e.g., Dufferin Island and Welland River/Lyon's Creek, Middle Island [historical] and Pelee Island-South shore). Future genetic analyses (see **Population Spatial Structure and Variability**) should provide some initial insight into this entirely unknown aspect of the Canadian population.

Fluctuations and Trends

As for overall historical trends for the Canadian population, American Water-willow is in decline. The smaller subpopulations (Île Bélair, Leamington, Saint-Michel-de-Bellechasse, Sharbot Lake) may only be ephemeral colonies, a phenomenon previously observed in Ontario (Parks Canada Agency 2011). The Île Bélair and Sharbot Lake subpopulations were not found in 2018.

At the time of the last status report (White 2000), the Canadian population was about 2,730,000 individuals but Labrecque (pers. comm. 2021) recently stated that the early population estimates from Rivière des Mille-Îles are an underestimate as observers did not attempt to survey the whole subpopulation. In 2007, the total Canadian population was estimated at nearly 25,500,000 stems (Parks Canada Agency 2011) based on the most recent surveys by the NHIC (2010), CDPNQ (2006), and Bisson and Gauvin (2008). This is an increase of over eight times, but as stated, the early estimates are considered low. The 2020 estimate (1,432,595 stems) is only about 5.6% of the 2007 estimate. This dramatic decline is mainly the result of the even more dramatic decline in the Rivière des Mille-Îles subpopulation. The total number of stems shown for the Rivière des Mille-Îles subpopulation in the recovery strategy (Parks Canada Agency 2011) is not accurate

because it does not include the eastern portion of the subpopulation, which totalled approximately 104,261 stems (Bisson *et al.* 2006). The western and central portions of the subpopulation were estimated to support 25,323,757 stems in 2007 (Bisson and Gauvin 2008). The total estimated Rivière des Mille-Îles subpopulation in 2007, then, was 25,428,018 stems. Data used to assess current subpopulation numbers were generated in 2014 for the western and central portion of the subpopulation and in 2018 for the eastern portion. The combined total for 2014, 2018 and 2020 (1,176,101 stems) represents 4.6% of the 2007 total.

Data for the areas occupied between 2004 and 2014 inclusively, are presented in Table 2. They show that the monitored portion of the Rivière des Mille-Îles subpopulation experienced a significant decline in area and abundance between the start and end of monitoring. The subpopulation had remained fairly stable from 2004 to 2007 and then began a gradual decrease in 2009, followed by a marked downtrend in 2010. The estimated area for 2014 (19,530.72 m^2) is 56.5% of that for 2007 (34,548.1 m^2). Because abundance underwent a much greater decline than area over this period, it indicates that stem density experienced a major decline, but that the spatial extent of the colonies was substantially unchanged (albeit reduced in size), along the river.

Regarding the other extant subpopulations, various trends can be observed. The Dufferin Island and Welland River/Lyon's Creek subpopulations are expanding. Although subpopulation size has fluctuated, and five sampling years may be insufficient to detect long-term trends, model population projections could be useful. The Île Rock subpopulation has stabilized after a period of strong growth. Some very small subpopulations are stable (Leamington and Saint-Michel-de-Bellechasse), whereas others are in decline (Point Pelee National Park, Godefroy River) or were not located during the most recent visit (Île Bélair, Sharbot Lake). The trend for the other extant subpopulations is unknown, because they have not been surveyed often or recently enough (Grenadier Island, Hill Island, Pelee Island-South shore). None of the historical subpopulations were found but all were revisited. In the case of the Rivière des Prairies and Longueuil subpopulations, the historical records were not associated with a precise locality, and the potential habitat covered large expanses; the survey conducted in 2018 can be considered only partial.

The Rivière des Mille-Îles subpopulation seems to have stabilized following its major decline. Some other smaller subpopulations are in decline while others are increasing and yet others are stable. Accordingly, it is difficult to predict the future trend for the Canadian population.

Rescue Effect

Given the American Water-willow's considerable capacity for vegetative propagation, new colonies potentially can quickly form from fragments produced by an existing colony. American Water-willow occurs in the northern portions of all U.S. states bordering Lakes Erie and Ontario (Kartesz 2015). The Hill Island and Grenadier Island subpopulations are located adjacent to subpopulations on Wellesley Island, New York (NHIC 2018). Accordingly, rescue effect from U.S. occurrences is possible for only some subpopulations, mostly those from Lake Ontario.

THREATS AND LIMITING FACTORS

Threats

Although in the past, habitat loss through infilling contributed to the disappearance of a number of subpopulations (Parks Canada Agency 2011), this is not the greatest threat at present. Direct threats facing American Water-willow assessed in this report were organized and evaluated based on the IUCN-CMP (World Conservation Union-Conservation Measures Partnership) unified threats classification system (Master *et al.* 2012; NatureServe 2015). Threats are defined as the proximate activities or processes that directly and negatively affect the population. Results on the impact, scope, severity, and timing of threats are presented in tabular form in Appendix 1. The overall calculated and assigned threat impact is Very High to High for American Water-willow.

7.2 Dams and water management/use (Medium – Low impact)

Nearly all the extant subpopulations are affected to some extent by water level management, whether in connection with the St. Lawrence Seaway or with hydroelectric dams and other facilities. The species is tolerant of large water level fluctuations, but a significant increase or decrease in level could reduce the amount of available habitat. This threat affects nearly all subpopulations. In the context of climate change, where the frequency of extreme weather events is expected to increase in the regions concerned, it is conceivable that water level management decisions along the Great Lakes–St. Lawrence system will give priority to public safety and economic imperatives over species at risk habitat conservation.

Susceptibility to damaging freezing of roots and stolons is a concern when water levels are low. For example, Hill Island and Grenadier Island subpopulations are subject to annual water level variations of approximately 60 to 90 cm due to artificial control of water levels by dams (Ontario Ministry of Natural Resources 2013).

Two subpopulations, Welland River and Lyon's Creek, could be impacted by work being undertaken to increase the efficiency of the hydroelectric facility as it will result in alteration of water flow on the Welland River (Benner 2018). However, the impacts of the changes on the species are uncertain because the expected modifications to water levels

and flows have not yet been determined. In a greenhouse experiment, Touchette *et al.* (2008) found American Water-willow was sensitive to drought conditions "as indicated by complete mortality for all drought treated plants after 3 weeks of water stress."

8.1 Invasive and other problematic species and genes (Very High to High impact)

The presence of invasive alien species has been assessed as a very high to high impact threat. European Reed (*Phragmites australis* ssp. *australis*) and Blue Cattail (*Typha x glauca,* aka Hybrid Cattail) are the main invasive alien species currently known to compete with American Water-willow (Parks Canada Agency 2011; Di Fiore 2020).

11. Climate change and severe weather (Medium to Low impact)

Climate change could lead to substantial changes in precipitation regimes and hydrological conditions. A combination of low water levels and cold temperatures could lead to high mortality in American Water-willow if the plants' stolons and rhizomes are directly exposed to freezing. These threats are considered to be of medium to low impact because although a number of extreme weather events have already occurred, it is difficult to predict their frequency and intensity in the future, or their potential impacts on subpopulations. The risks associated with climate change affect the species throughout its range.

Other Threats

Recreational activities, as well as residential and commercial development present low-intensity or localized potential impacts affecting only a few subpopulations at most. St. Lawrence Seaway ship-generated wave action is an uncertain but essentially irreversible threat. Alternatively, it may constitute a positive force for new habitat creation.

Limiting Factors

Vegetative propagation, the species' main mode of reproduction in Canada, limits genetic diversity. It can make the species more vulnerable to environmental changes (White 2000). The dynamic nature of the sites that this species occurs in can limit its establishment and persistence.

Number of Locations

The number of known extant subpopulations for American Water-willow is 13, although two historical subpopulations are presumed extant, for a total of 15. However, it is possible that some of the smaller subpopulations are ephemeral (i.e., Île Bélair, Saint-Michel-de-Bellechasse, Sharbot Lake, and Pelee Island-South shore) and should not be considered established subpopulations. The most serious plausible threats are invasive species and fluctuating water levels due to climate change or water management. There is no information to suggest that any of the subpopulations should be separated into multiple locations based on the most serious plausible threat. As such, the number of locations is as low as 11 and as high as 15. Three of the historical subpopulations were not included as they have not been re-located for at least 30 years and are likely extirpated.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

COSEWIC assessed American Water-willow as threatened in 1984. The status was re-examined and confirmed in 2000. American Water-willow was added to Schedule 1 of the *Species at Risk Act* in 2003. It was designated as threatened under the Quebec *Act Respecting Threatened or Vulnerable Species* in 1998. In Ontario, the species was assessed as threatened under the *Endangered Species Act* in 2008 (Parks Canada Agency 2011). Various forms of legal protection apply, including protection of the plant and prohibitions against harvesting the plant or any of its parts, without authorization. This species is not included in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). A recovery strategy (Parks Canada Agency 2011) identified critical habitat for each of the 10 extant subpopulations known at the time. A number of the recovery and performance measures set out in the strategy appear not to have been implemented, including maintaining or increasing the number of individuals, contacting or raising awareness among more than 60% of landowners adjacent to extant populations, and preparing an action plan by January 2016. The number of legally protected sites has increased and the 10 subpopulations for which critical habitat was mapped are still present.

A conservation plan was produced for Quebec subpopulations in 2007. It set out priority actions within a five-year horizon (Jolicoeur and Couillard 2007). One of the actions, the assignment of plant habitat status to the Rivière des Mille-Îles subpopulation, was achieved in 2011. Demographic monitoring of certain subpopulations has continued, signage has been erected, and user awareness measures have also been carried out or are currently under way. Actions not yet implemented include the assessment of the impact of White-tailed Deer browsing on the Godefroy River and Mille-îles subpopulations, fine-scale characterization of the microhabitats of the different subpopulations, and the continuation of transplant and growing trials (Jolicoeur and Couillard 2007). A conservation plan is currently implemented for the Île Rock subpopulation (Di Fiore 2020).

In Ontario, surveys conducted from 2006 to 2010 found some new subpopulations and ascertained that others appeared to have disappeared. Development of a recovery strategy for the species was initiated (OMNR 2013) but is incomplete.

Non-legal Status and Ranks

American Water-willow has a NatureServe global rank of G5 and a national rank of N5 in the United States, which indicates the species is not at risk of extinction or extirpation and is common and abundant. Its status in Canada is N2N3, which means the species is considered to be at high to moderate risk of extinction or extirpation. In Quebec and Ontario, the subnational rank is S2, which means that the species is at high risk of extirpation (Tardif *et al.* 2016). The original COSEWIC assessment determined the status of the species as Threatened in 1984, which was confirmed in 2000.

In the United States, American Water-willow is found in most eastern states, and its conservation status rank is designated “endangered” in Iowa, “threatened” in Michigan, “vulnerable” in Louisiana, and “extirpated” in Vermont. In seven states, the species has a secure conservation status and in sixteen others, it has not been ranked.

Habitat Protection and Ownership

Because the habitat of American Water-willow is located along the shores of lakes and rivers, the species occurs mainly on provincially or federally managed property. Some subpopulations (3) may be located partly on private land. Several of the subpopulations are included within protected areas. In total, 9 extant or presumed extant subpopulations are included in protected areas, whether a federal national park, provincial parks, or Quebec Plant Habitats (Table 3). In addition, the recently discovered Saint-Michel-de-Bellechasse subpopulation will be included within the relocated boundaries of an existing Plant Habitat (B. Tremblay pers. com.). If this upcoming legal protection is included, the majority of subpopulations are included in or are immediately adjacent to protected areas.

Table 3. Land tenure and protective measures for extant subpopulations of American Water-willow.

Subpopulation	Province	Name of site	Trend	Status	Tenure	Protection
2	Ontario	Point Pelee National Park	decline	extant	Federal land	National park
4	Ontario	Rondeau Peninsula and Harbour Wetlands	presumed extant	historical	Public	Provincial park
6	Ontario	Long Point National Wildlife Area	presumed extant	historical	Federal land	National Wildlife Area
9	Ontario	Port Burwell provincial Park	extirpation	historical	Public	Provincial park
10	Ontario	Welland River/Lyon’s Creek (portion Welland River)	unknown	extant	Public and private	

Subpopulation	Province	Name of site	Trend	Status	Tenure	Protection
10	Ontario	Welland River/Lyon's Creek (portion Lyon's Creek	growing	extant	Public and private	
11	Ontario	Dufferin Island	growing	extant	Public	
12	Ontario	Pelee island - South shore	unknown	extant	Public	
13	Ontario	Hill Island	unknown	extant	Public	
14	Ontario	Grenadier Island	unknown	extant	Public	
15	Ontario	Marina of Leamington	maintenance	extant	Public	
16	Ontario	Sharbot Lake	extirpation	extant	Public and private	Provincial park
18	Quebec	Rivière des Mille-Iles (eastern portion)	decline	extant	Public	Plant habitat
18	Quebec	Rivière des Mille-Iles (western and central portion)	decline	extant	Public	Plant habitat
19	Quebec	Godefroy River	decline	extant	Public	Ecological reserve and plant habitat
24	Quebec	Île Rock	maintenance	extant	Public	Plant habitat
25	Quebec	Île Jésus, Rivière des Prairies	extirpation	historical	Public	
28	Quebec	Longueuil	extirpation	historical	Public	
29	Quebec	Île Bélair	extirpation	extant	Public	
30	Quebec	Saint-Michel-de-Bellechasse	maintenance	extant	Public	

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Liette Vasseur	Professor	Department of Biological Sciences at Brock University	St. Catharines	Ontario

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BIOGRAPHICAL SUMMARY OF REPORT WRITER(S)

Audrey Lachance has expertise in the characterization of natural habitats and exceptional forest ecosystems, wetland identification and delineation and rare plant surveys and monitoring. She received a diploma in natural environment technology, wildlife management in 2005. For several years, she has been involved in carrying out population inventories and monitoring and in drafting a variety of documents on various plant species at risk, including American Ginseng (*Panax quinquefolius*), Victorin's Gentian (*Gentianopsis virgata* subsp. *victorinii*), Victorin's Water-hemlock (*Cicuta maculata* var. *victorinii*), Parker's Pipewort (*Eriocaulon parkeri*), Provancher's Fleabane (*Erigeron philadelphicus* var. *provancheri*) and Van Brunt's Jacobs-ladder (*Polemonium vanbruntiae*). Audrey Lachance is a member of two recovery teams (threatened plants of the freshwater estuary of the St. Lawrence and Van Brunt's Jacob's-ladder). She also carries out work on rare species in Quebec and assists with the assessment of threats to and the vulnerability of rare plants to climate change. She recently drafted a case study on assisted migration involving Meadow Thistle (*Cirsium scariosum* var. *scariosum*).

Olivier Deshaies is a biologist with a master's degree in wildlife and wildlife habitat management (2012). He co-authored a scientific article published in *Forest Ecology and Management* (2014) concerning the biological legacy of forest management for understorey vegetation in boreal mixed forests of North America. More recently, he has specialized in plant ecology in southern Quebec, first as an employee of a consulting firm and then as a member of the Bureau d'écologie appliquée. Mr. Deshaies has developed excellent skills in the characterization of natural environments, including expertise in wetland and critical habitat delineation and in rare plant surveys. He offers various training courses to other environmental professionals in Quebec in his areas of expertise.

COLLECTIONS EXAMINED

Data from Quebec herbarium specimens were consulted using tools available online. No herbaria were visited.

Appendix 1. Threats calculator on American Water-willow.

Species or Ecosystem Scientific Name	*Justicia americana* - American Water-willow			
Element ID	2297 (QC), 158000 (ON)		**Elcode**	
Date	12/11/2019			
Assessor(s):	Dwayne Lepitzki (moderator), Del Meidinger (Co-chair), Audrey Lachance (writer), Stephanie Pellerin (SSC), Sam Brinker (SSC/ON), Bruce Bennett (SSC), Jacques Labrecque (QC), Christina Rohe (CWS), Tammy Dobbie (Pt Pelee NP)			
References:				
	Overall Threat Impact Calculation Help:		**Level 1 Threat Impact Counts**	
	Threat Impact		**high range**	**low range**
	A	Very High	1	0
	B	High	0	1
	C	Medium	2	0
	D	Low	2	4
	Calculated Overall Threat Impact:		Very High	High
	Assigned Overall Threat Impact:		**AB = Very High - High**	
	Impact Adjustment Reasons:		Plausible that threats could result in significant decline over three generations as there has already been a big decline at Mille-Îles and invasive plants, especially European Reed, are a future concern.	
	Overall Threat Comments		Generation length unknown; as a long-lived clonal species, likely 10-15+ years, so 3 generations => 30-45 years; % of Canadian population in each subpop: 82% R. des Mille-Îles; 8% Welland RIver/Lyon's Creek; 4% each Hill Island Île Rock; 1.4% Dufferin Island; rest < 1%; ~94.4% population decline last 10 years attributed mostly to R. des Mille-Îles	

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development	D	Low	Small (1-10%)	Extreme (71-100%)	High (Continuing)	
1.1	Housing & urban areas	D	Low	Small (1-10%)	Extreme (71-100%)	High (Continuing)	High impact where development would occur.
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas		Negligible	Negligible (<1%)	Extreme (71-100%)	High - Moderate	In QC the species is protected but some development is possible with mitigation. In ON, there are avenues to apply for exemptions. The designation may not ensure protection.
2	Agriculture & aquaculture						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture						
3	Energy production & mining						
3.1	Oil & gas drilling						
3.2	Mining & quarrying						
3.3	Renewable energy						
4	Transportation & service corridors		Unknown	Small (1-10%)	Unknown	High (Continuing)	
4.1	Roads & railroads						
4.2	Utility & service lines						
4.3	Shipping lanes		Unknown	Small (1-10%)	Unknown	High (Continuing)	Île Rock and Welland R sites in shipping lanes; wakes from ships, both positive and negative effects--wave action causes erosion but also maintains open habitat. Shallow dredging done at the mouth of the Mille Îles River in 2010, as river water level was too low. Possible that more dredging will be done to improve water flow in low water years but timing and impact unknown.
4.4	Flight paths						
5	Biological resource use		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						
5.2	Gathering terrestrial plants		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	Some research collecting, but minor. Proposed exotic species control in the habitat, e.g., for European Reed, could potentially impact American Water-willow plants.
5.3	Logging & wood harvesting						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	
6.1	Recreational activities	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Includes trampling by kayakers and hunters along shore. Kayakers may fragment plant when paddling over. Local trampling at Point Pelee and Île Rock; experience at Pt Pelee is of slight impact.
6.2	War, civil unrest & military exercises						
6.3	Work & other activities						
7	Natural system modifications	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	
7.1	Fire & fire suppression						
7.2	Dams & water management/use	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	Niagara River water management and Great Lakes; and proposed work on Welland River. Concern is impact from spring freezing during low water levels. Dams have been around for a while, but how they are managed has changed; impact scored as a range as actual impact uncertain.
7.3	Other ecosystem modifications						Riprap added to Leamington subpopulation; plants sprouted through riprap.
8	Invasive & other problematic species & genes	AB	Very High - High	Pervasive (71-100%)	Extreme - Serious (31-100%)	High (Continuing)	
8.1	Invasive non-native/alien species/diseases	AB	Very High - High	Pervasive (71-100%)	Extreme - Serious (31-100%)	High (Continuing)	Abundant invasives in some subpopulations, including European Reed and Blue Cattail; European Reed invasion at Montréal Botanical Garden resulted in 100% decline of American Water-willow. Observed declines at Île Rock.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.2	Problematic native species/diseases		Negligible	Negligible (<1%)	Unknown	High (Continuing)	White-tailed Deer impact, where deer numbers high due to no hunting in protected area (e.g., Godefroy River). Browsing was also assumed to have impacted the historical subpopulation of Hill Island (Parks Canada Agency 2011). The impact of browsing on current subpopulations has been identified as a threat that needs to be documented (Couillard and Jolicoeur 2007; Parks Canada Agency 2011)—its impact is still unknown.
8.3	Introduced genetic material						
8.4	Problematic species/diseases of unknown origin						
8.5	Viral/prion-induced diseases						
8.6	Diseases of unknown cause						
9	Pollution		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Effect of pollution from various sources is unknown
9.1	Domestic & urban waste water		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
9.2	Industrial & military effluents						Not a lot of industry in the areas
9.3	Agricultural & forestry effluents		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
9.4	Garbage & solid waste		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
9.5	Air-borne pollutants						
9.6	Excess energy						
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	
11.1	Habitat shifting & alteration						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.2	Droughts	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	Freezing at low water level is main concern
11.3	Temperature extremes	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	Spring freezing with low water levels.
11.4	Storms & flooding	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	Erosion caused by climate change will result in loss of habitat; storm energy; lack of ice cover due to climate change, less protection of shoreline in winter.
11.5	Other impacts						
Classification of Threats adopted from IUCN-CMP, Salafsky *et al*. (2008).							