RECOVERY PLAN FOR HOARY WILLOW (*SALIX CANDIDA* FLŰEGGÉ EX WILLD.) IN NOVA SCOTIA

A report prepared for the Nova Scotia Department of Lands and Forestry

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[FINAL]

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Cover illustration: Photograph by Ruth & Reg Newell

PREFACE

This Recovery Plan has been prepared by the responsible jurisdiction, the Nova Scotia Department of Lands and Forestry, in cooperation with the Nova Scotia Plants Recovery Team. The Recovery Plan outlines the recovery goals, objectives, and actions that are deemed necessary to protect, conserve, and recover Hoary Willow in Nova Scotia.

Recovery plans are not designed to provide a comprehensive summary of the biology and status of Species at Risk in Nova Scotia. For more information regarding Hoary willow, consult the Nova Scotia Provincial Update Status Report (Nova Scotia Department of Lands and Forestry 2021).

Under the *Nova Scotia Endangered Species Act* (2007), a Recovery Plan must be developed for species listed as Endangered or Threatened under the Act and include the following:

- Identification of the needs and threats of the species;
- The viable status needed for recovery;
- The options for recovery as well as the costs and benefits of these options;
- The recommended course of action or combination of actions to achieve recovery of the species;
- A schedule for implementation of the recovery plan including a prioritized listing of recommended actions;
- Identification of habitat, and;
- Identification of areas to be considered for designation as core habitat.

The goals, objectives, and actions identified in this Recovery Plan are based upon the best available information on the species and are subject to modifications and/or revisions as new information becomes available. Recovery of species at risk is a shared responsibility and the collaborative approach emphasized in this document is reflective of that. Implementation of the actions and approaches identified in this plan are subject to budget constraints, appropriations, and changing priorities.

ACKNOWLEDGEMENTS

The province contracted Reg. B. Newell and Ruth E. Newell to draft this Recovery Plan in consultation with members of the Nova Scotia Plants Recovery Team and the Nova Scotia Department of Lands and Forestry.

The Department would like to thank those individuals and/or organizations who have contributed to the recovery of Hoary willow in Nova Scotia. In particular, the following members of the Nova Scotia Plants Recovery Team are recognized for their significant contributions to the development of this Recovery Plan:

- Alain Belliveau
- Sean Blaney
- Dr. Nick Hill
- Dr. Donna Hurlburt
- Dr. Jeremy Lundholm
- David Mazerolle

EXECUTIVE SUMMARY

Hoary willow is a low, deciduous, dioecious shrub native to the boreal and north temperate regions of North America. In Nova Scotia, it is restricted to the unique alkaline fens and associated floodplains of the Black River watershed, situated at the northwest end of Lake Ainslie, Inverness County, Cape Breton Island. Most of the 8-9 recorded sites are in close proximity to each other (within 2 km). Hoary willow is limited by its rarity within Nova Scotia and isolation from populations outside of the province. It is also limited by its very specific germination and habitat requirements. Although considered relatively secure throughout the rest of its range, Hoary willow was listed as "Endangered" under the Nova Scotia Endangered Species Act in 2013.

The restricted nature of its distribution makes Hoary willow particularly susceptible to threats and escalates the potential impacts of even low occurrence events should they arise. Threats to Hoary willow include agricultural activities (e.g., grazing, effluents), logging and wood harvesting, OHV activities and invasive species. Other potentially significant threats with unknown consequences include fire and fire suppression, wildlife grazing, beaver activity, and habitat shifting due to climate change. Additional future threats include fracking and peat mining, both of which have potential to occur in the longer term (>10 years) and could have significant effects in the Black River watershed. Hoary willow is a shade-intolerant species that depends on localized disturbance events to maintain open habitats for establishment, and some threats such as fire regimes or beaver activity may potentially have both negative and positive effects. The history of natural disturbances in the area is poorly understood, making these difficult to evaluate.

The viable status for recovery of the species, intended as a long-term goal of removing Hoary willow from the *Nova Scotia Endangered Species Act* (NSESA), would need to include establishment of Hoary willow outside the Black River system, i.e., in separate watersheds so that all plants are not subject to the same threats. In the absence of historical population data, research is needed to determine if this is a feasible and recommended course of action. An interim long-term recovery goal (>20 years) is to maintain and promote conditions that allow for a self-sustaining and ecologically functioning population within the province, including: (1) increase the Hoary willow population within the Black River watershed and; (2) consider experimental planting in suitable habitat elsewhere. Projected numbers of individuals are subject to further research but should reflect an increase from current estimates. The short-term (5 year) population and distribution objective is to maintain current numbers of at least 1300-1600 individuals at existing sites in the Black River watershed (i.e., no loss of numbers of individuals or sites over 5 years).

Broad recovery measures and actions are identified to address threats, protect and enhance habitat (including core habitat), improve communication and outreach, advance policy and guidance to support recovery, and provide a basis for surveys and assessment. In particular, protection of land in the Black River watershed through purchase, leasing or conservation agreements, defining and designating core habitat under the NSESA, raising awareness among private landowners, and research to address significant knowledge gaps, are important priorities.

RECOVERY FEASIBILITY SUMMARY

The recovery of Hoary willow in Nova Scotia is considered technically and biologically feasible if the following four criteria can be met:

1. Individuals of the species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.

Yes. Hoary willow is capable of reproduction if the current population[1] is protected, although mitigation measures may be needed to sustain and support it in the future if habitat quality deteriorates.

2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.

Yes. There is habitat within the Black River watershed that currently supports Hoary willow and potentially suitable additional habitat exists elsewhere in Cape Breton and mainland Nova Scotia (e.g., fens and swamps underlain by gypsum deposits).

3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.

Yes. Subject to a better understanding of the impacts of some threats (e.g., fire suppression, beaver activity), all of the primary threats that are currently known could be avoided or mitigated, with the possible exception of climate change.

4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.

Yes. Hoary willow can be propagated vegetatively and research can be done to identify new potential habitat and develop techniques to achieve population and distribution objectives for species recovery.

The Recovery Team concludes that the recovery of Hoary willow in Nova Scotia is technically and biologically feasible based on the criteria discussed above.

[1] Population is defined as the total number of individuals of the taxon (COSEWIC 2019), in this case in Nova Scotia.

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1. NSSARWG ASSESSMENT SUMMARY

Date of Assessment Summary: June 2019

Common Names: Hoary willow, Sage willow, Sage-leaved willow

Scientific Name: *Salix candida* Flűeggé ex Willd.

Status: Endangered

Reason for Designation: Hoary willow's distribution in Nova Scotia is limited to one wetland system in Inverness County, Cape Breton, where it occurs in unique alkaline fen and floodplain habitats. Population size is difficult to assess due to asexual reproduction through rhizomes but is estimated at 1300-1600 individuals. Slight decreases have been observed since 2010, though historical data are lacking and population dynamics are poorly understood. The small and isolated nature of the population makes it extremely vulnerable to threats that may alter wetland hydrology or affect natural succession, including: agricultural activities, small-scale logging, off-highway vehicle (OHV), invasive species, and in the longer-term, possibly fracking and peat mining. Potentially significant threats that are poorly understood include fire suppression, beaver activity and climate change. Rescue effect is considered unlikely with the nearest populations in Prince Edward Island and New Brunswick.

Nova Scotia Occurrence: Inverness County.

Status History: Designated Endangered under NSESA in 2013 when first status report was written. Re-assessed as Endangered by NSSARWG in 2019.

* The following definitions are applicable in this section and elsewhere: NSSARWG (Nova Scotia Species at Risk Working Group); COSEWIC (Committee on the Status of Endangered Wildlife in Canada); NSESA (Nova Scotia Endangered Species Act); SARA (Species at Risk Act).

2. SPECIES STATUS INFORMATION

Hoary willow is considered globally secure (G5) and also has a national rank of secure in Canada (N5) (Table 1); it is not listed under Canada's Species At Risk Act (SARA) or by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Across its distribution in Canada it is designated as secure in British Columbia, Manitoba, Ontario and Quebec (S5/S5?), apparently secure in Alberta, Saskatchewan, Newfoundland and Northwest Territories (S4), apparently secure to vulnerable in Yukon Territory (S3S4), vulnerable to imperiled in Labrador (S2S3), imperiled in New Brunswick (S2), critically imperiled in Nova Scotia and Prince Edward Island (S1), and unrankable in Nunavut; due to lack of information (SU) (Canadian Endangered Species Conservation Council 2016; NatureServe 2019).

Table 1. NatureServe conservation status ranks for Hoary willow in Canada* (Canadian Endangered Species Conservation Council 2016; NatureServe 2019).

Global (G) Rank[a]	National (N) Rank[b]	Subnational (S) Rank[c]
G5	N5	S4 – Alberta S5 – British Columbia S2S3 – Labrador S5? – Manitoba S2 – New Brunswick S4 – Newfoundland S4 – Northwest Territories S1 – Nova Scotia SU – Nunavut S5 – Ontario S5? – Quebec S1 – Prince Edward Island S4 – Saskatchewan S3S4 – Yukon Territory

[a] G-Rank – Global Conservation Status Rank, G1 = Critically Imperiled; G2 = Imperiled; G3 = Vulnerable; G4 = Apparently Secure; G5 = Secure

[b] N-Rank –National Conservation Status Rank, N1 = Critically Imperiled; N2 = Imperiled; N3 = Vulnerable; N4 = Apparently Secure; N5 = Secure

[c] S-Rank – Sub-national (provincial or territorial) ranks, S1 = Critically Imperiled; S2 = Imperiled; S3 = Vulnerable; S4 = Apparently Secure; and S5 = Secure. B = breeding; and U = Unrankable.

*A full list of definitions can be found in Definitions of NatureServe Conservation Status Rankings at http://help.natureserve.org/biotics/Content/Record_Management/Element_Files/Element_Tracking/ETRACK_Definitions_of_Heritage_Conservation_Status_Ranks.htm

3. SPECIES INFORMATION

3.1 Species Description

Hoary willow is a deciduous, dioecious, low to mid-sized shrub that grows 0.3-2.5 m tall and is densely white and woolly on the current season's twigs and lower leaf surfaces. The mature medial leaves are narrowly elliptic or oblanceolate, usually at least four times long as wide (50-100 mm x 5-20 mm). Leaf margins are entire and slightly to strongly rolled under. Flowering occurs concurrently with leaf emergence. Unisexual, non-showy flowers occur in catkins, with male and female catkins found on separate plants. Female flowers have stalks 0.1 to 1.2 mm long and tomentose pistils. The anthers of male flowers are purple in colour, later changing to yellow. The fruit is a tomentose, pear-shaped capsule. Reproduction is both sexual and asexual by layering. See the Nova Scotia Provincial Update Status Report (Nova Scotia Department of Lands and Forestry 2021) for a more detailed description and references.

3.2 Population and Distribution

Hoary willow is a boreal and north temperate species that occurs only in North America. Its distribution is concentrated in the northern United States and Canada (Decker 2006).

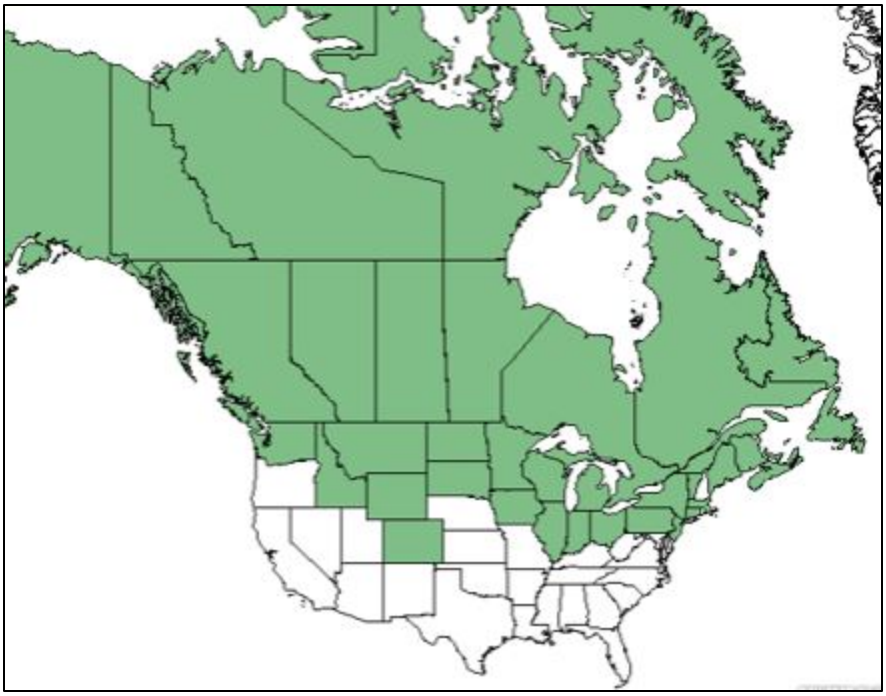

Figure 1. Distribution of Hoary willow in North America, shown as presence/absence by state and province (USDA-NRCS 2020).

In Canada, Hoary willow occurs in all provinces and territories (Figure 1). It also occurs in Saint Pierre and Miquelon, a French archipelago off the southern coast of Newfoundland. Although geographically wide ranging, this willow species is limited to calcareous habitats and for that reason, is quite local or even rare in many parts of its range (Argus 2006; 2010).

In Nova Scotia, Hoary willow is extremely rare, known to occur only within the Black River system situated at the northwest end of Lake Ainslie, Inverness County, Cape Breton Island. Here it is known primarily from five rich calcareous fens; four in close proximity to the Black River floodplain and one near a tributary (Saddlers Brook) to Black River (Figure 2). There are also a limited number of plants recorded in two calcareous graminoid marshes in this general area plus a single depauperate plant in a wetland south of Blackstone Road. An additional single plant was found in a mesic roadside location (Blackstone Road) in 2015 in atypical habitat for Hoary willow and was not relocated in surveys in 2018.

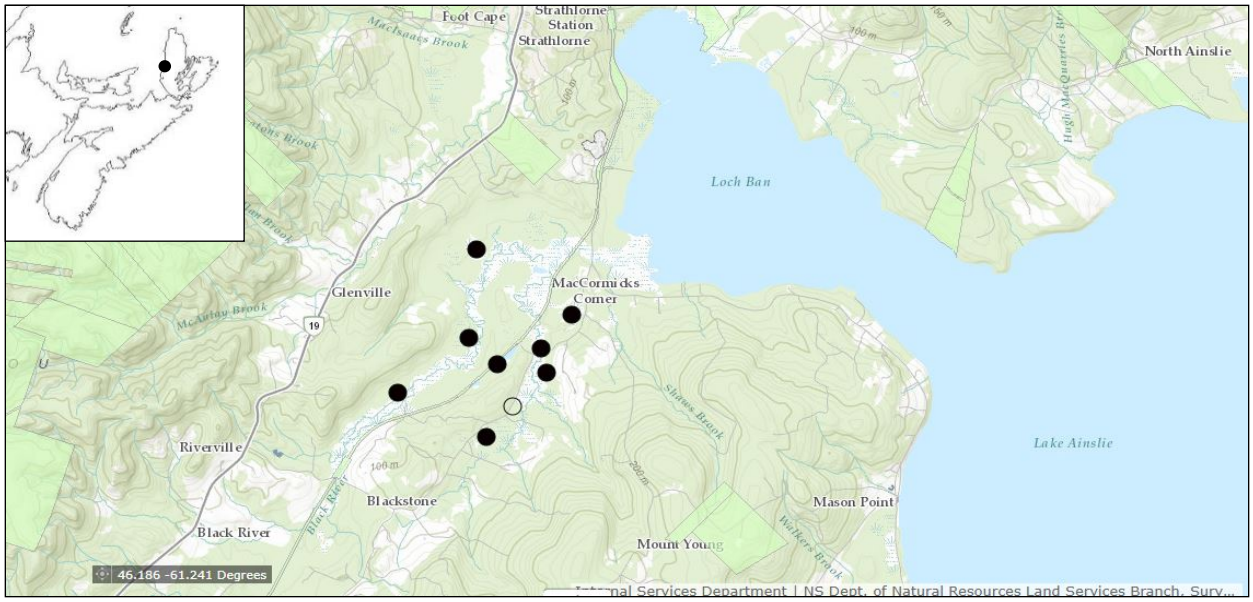

Figure 2. Current known sites where Hoary willow occurs in Nova Scotia (black dots). The open circle indicates a 2015 report of a single plant of Hoary willow in mesic roadside habitat that was not relocated by the authors in 2018 (Base map provided by the Nova Scotia Department of Lands and Forestry).

3.2.1 Population Size and Trends

The current estimate of mature individuals of Hoary willow in Nova Scotia is 1300-1600, based on observations by R. E. Newell and R. B. Newell in 2018. This represents a slight decline from the 2010 count of ~1500-2000 individuals reported in the first status report (Newell 2010; Nova Scotia Department of Lands and Forestry 2021).

It is likely that the number of mature individuals present within the Black River wetland complex is higher than the numbers reported. The fen habitats are challenging to survey and the surrounding area has not been thoroughly investigated. Surveys conducted in 2018 focused primarily on determining changes in numbers of individuals at previously documented sites. It is considered highly likely that additional plants will be located with further survey initiatives.

The original status report (Newell 2010) represented the first baseline population estimates for Hoary willow in Nova Scotia, and there are no additional historical data on which to base population trends. A comparison of 2010 and 2018 data for individual fens and marshes shows some variation between counts. This may be due to differences in individual counting methods or how thorough a survey was within each wetland. There are challenges associated with determining individual plants of Hoary willow because of its ability to propagate vegetatively by layering. However, two fens showed significant population declines. It is difficult to determine the cause of these declines, but they may be due to woody species' encroachment of open fen habitat. Willows are shade-intolerant and will decline as habitats become stabilized and are invaded by taller vegetation (Argus 2006).

No seedlings were observed during field work conducted for the Status Report (Nova Scotia Department of Lands and Forestry 2021). Vegetation is generally very dense in much of the habitat where Hoary willow occurs, making seed germination and ensuing seedling survival unlikely. Habitat disturbance is apt to promote willow seed germination. Seedling survival is dependent upon presence of adequate moisture and the absence of shade (Argus 2006).

However, willows can survive for many years without seedling recruitment, spreading instead by vegetative reproduction. Because Hoary willow is a perennial there is likely no to very little fluctuation in population size from year to year. It is likely that Hoary willow has always been rare in Nova Scotia due to the rarity of its specialized habitat, i.e., calcareous fen.

3.3 Species Needs

3.3.1 Habitat Needs

Globally, Hoary willow has been reported from a variety of wetland types including fens, bogs, and marshes, particularly those habitats with permanently saturated soils where peat is present along with a high mineral content and alkaline pH (Decker 2006). It has also been reported from river floodplains, marl bogs, fens, and meadows – on calcareous substrate in all cases (Argus 2006).

In Nova Scotia, Hoary willow appears to be limited to rich calcareous (alkaline) fens and marshes in the Black River system of Inverness County. These fens occur primarily in forest openings in close proximity to the Black River floodplain. They have a moderate to high shrub and tree component as well as a unique assemblage of graminoid and forb species, many of which are rare. The Black River system is also home to the provincially threatened tree species Black ash (*Fraxinus nigra*) as well as a rare butterfly and at least fourteen tracked bird species (Klymko et al. 2012; Churchill and Blaney 2018). The underlying geologic strata in the Black River area belong to the Windsor Group which include marine and evaporite deposits (Davis and Browne 1996).

3.3.2 Biological Needs and Ecological Role

Hoary willow is a long-lived perennial species that devotes several years to vegetative growth before reproducing. It reproduces sexually by seed and vegetatively by layering, although it is not known to what extent these occur in Nova Scotia. It is dioecious (i.e., male and female flowers produced on separate plants), which helps to ensure cross-pollination (Decker 2006).

Much of the research that has been carried out on willow biology has been conducted on willow species other than *Salix candida*. Willows are known to be mainly insect-pollinated, but also produce pollen that is wind-dispersed (Decker 2006). Seeds of most willows are non-dormant and short-lived and require moisture and the absence of shade for germination and seedling survival (Argus 2006; Decker 2006). The seeds of willows in general have a very limited window in which to find suitable habitat for germination

and growth. If suitable habitat is not found, seedling cohorts can experience 80-100% mortality (Argus 2006).

Willow seed dispersal is by wind and/or water although dispersal by wind is reported to be more common than water dispersal (Cremer 2003). The seed coma (a ring of fine, silky hairs) facilitates dispersal by wind. When seeds become wet, the hairs collapse and release the seed (Argus 1986). Decker (2006) suggests that wind dispersal is likely the primary dispersal mechanism for Hoary willow, while water dispersal is apt to play a bigger role in the dispersal of riparian willow species. Conversely, much of the Hoary willow population in Nova Scotia occurs in riparian fen and floodplain marsh habitats suggesting that flood events could conceivably carry seeds over long distances provided they retain some buoyancy. Overall, in spite of the fact that willow seeds are small, lightweight and have a coma, long distance dispersal is considered to be the exception rather than the rule (likely more common in tall shrub and tree willows than in low shrub willows).

3.3.3 Limiting Factors

There are several biological and ecological factors along with the reproductive cycle and habitat requirements that appear to restrict the population expansion of Hoary Willow. These include the following:

Habitat Availability

As noted above, Hoary willow is strongly associated with rich, calcareous fens in Nova Scotia and the rarity of this highly specialized habitat is likely a significant limiting factor for the species' distribution. Other similar habitats within the immediate and general area of the Black River system as well as in other parts of Cape Breton Island have been surveyed by the Atlantic Canada Conservation Data Centre (AC CDC) and others, and none were found to have Hoary willow. Although more field investigations may yet discover new records of Hoary willow in the Black River area and potentially other alkaline sites, the rarity of this habitat type in Nova Scotia will heavily impact the recovery and expansion of this population.

Seed Dispersal

Although willow seeds appear well adapted for wind dispersal, studies have measured an approximately 90% reduction in seed rain density within 200m of parent plants of shrub willows (Gage and Cooper 2005). In Nova Scotia, the woodland surrounding most of the Black River fens may create barriers that reduce the ability of Hoary willow seeds to disperse. This would essentially limit dispersal to the parent fen; if the parent fen becomes unsuitable for the survival of Hoary willow or the establishment of seedlings, the population in that parent fen is unlikely to be replicated elsewhere. As noted above, it is possible that flood events and water-borne dispersal could play a role in transferring Hoary willow seed from one fen to another, however this would still limit dispersal to a

local (i.e., watershed) scale. More information on seed dispersal mechanisms and distances is needed.

Shade intolerance

Willows are shade intolerant and will decline as habitats become stabilized and invaded by taller vegetation (Argus 2006). When willows grow in a habitat with closed ground cover such as a fen or bog, they have difficulty reproducing by seed unless there is some disturbance (Argus 2006). Seedling survival is also dependent upon presence of adequate moisture and the absence of shade (Argus 2006).

Most of the sites where Hoary willow occurs in Nova Scotia are located in moderately dense, vegetated fens that are still open enough to allow adult plants to survive (Newell pers. obs. 2018). However, no seedlings were observed in the field, which may be due to the habitat being too densely vegetated for seed propagation. Most of the plants appeared to propagate asexually by layering (i.e. developing roots where outlying branches touch the ground) and forming a loose clump. This layering and clump formation may also reduce “crowding” by other species of a similar height reducing some potential shading. With a lack of natural disturbance in Hoary willow habitats such as fire, soil saturation or seasonal flooding, ecological succession will eventually lead to a shade density that may impact germination, seedlings and adult plants.

4. THREATS

4.1 Threat Assessment

The Hoary willow threat assessment (Table 2) is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system (IUCN 2012). Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (in this case, the province of Nova Scotia). Limiting factors are not considered during this assessment process. For purposes of the threat assessment, only present and future threats are considered. Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats are presented in Section 4.2 *Description of Threats*.

Table 2. Threat calculator assessment.

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Comments
1	Residential & commercial development					
1.1	Housing & urban areas					Not currently applicable; however, an increase in cottage development is possible in future, with international promotion of tourism and property / recreational values on Cape Breton Island. Although unlikely to occur directly in Hoary willow habitat (e.g., wetlands), development in the surrounding watershed could affect hydrology. This should be monitored.
1.2	Commercial & industrial areas					Not applicable.
1.3	Tourism & recreation areas					Not applicable.

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Comments
2	Agriculture & aquaculture	Low	Small	Slight to Moderate	High	
2.1	Annual & perennial non-timber crops					Not applicable.
2.2	Wood & pulp plantations					Not applicable.
2.3	Livestock farming & ranching	Low	Small	Slight to Moderate	High	Some localized grazing occurs in the Black River watershed; however, impacts are uncertain and may depend on intensity and location. There could be some benefits to moderate grazing. More research is needed.
2.4	Marine & freshwater aquaculture					Not applicable.
3	Energy production & mining	Not calculated (outside of assessment timeframe)	Pervasive	Serious	Low	
3.1	Oil & gas drilling	Not calculated (outside of assessment timeframe)	Pervasive	Serious	Low	There has been interest in fracking in the Lake Ainslie / Black River area. Fracking could affect hydrology thereby negatively impacting Hoary willow. Currently there is a provincial ban on fracking, making it unlikely to occur in the short-term. However, this is not a legislated moratorium and could be overturned in future, in response to market pressure.
3.2	Mining & quarrying	Not calculated	Pervasive	Serious	Low	Fuel and moss grade peat has been identified in the Black River

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Comments
		(outside of assessment timeframe)				system (Anderson and Broughm 1988). Although there are no current exploration licences or production leases in the area, there is a growing peat moss industry in North America, and peat mining may prove to be a future threat.
3.3	Renewable energy					Not applicable.
4	Transportation & service corridors					
4.1	Roads & railroads					Not currently applicable. A former railroad now used as a rail trail runs through the sites where Hoary willow occurs and could have affected the population in the past. New road construction is unlikely, although ongoing maintenance or repairs on existing roads and trails could have an impact on hydrology in future (e.g., culverts, bridges). This should be monitored.
4.2	Utility & service lines					Not currently applicable. However, the surrounding area is underserviced for internet and high-speed towers and lines will likely be going in soon (exact location unknown). This should be monitored.
4.3	Shipping lanes					Not applicable.
4.4	Flight paths					Not applicable.

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Comments
5	Biological resource use	Low	Restricted	Slight	Moderate	
5.1	Hunting & collecting terrestrial animals					Not applicable.
5.2	Gathering terrestrial plants					Not applicable.
5.3	Logging & wood harvesting	Low	Restricted	Slight	Moderate	There is not much harvestable wood mixed in with Hoary willow and current regulations restrict logging activities in wetlands (e.g. *Wildlife Habitat and Watercourses Protection Regulations*). However, there has been some evidence of logging being considered nearby (e.g., flag lines) and there is potential for small-scale harvesting on slopes surrounding the wetlands, which could affect water quality, temperature and hydrology; it is uncertain how this may affect Hoary willow.
5.4	Fishing & harvesting aquatic resources					Not applicable.
6	Human intrusions & disturbance	Low	Small	Serious	High	
6.1	Recreational activities	Low	Small	Serious	High	Limited OHV activity currently occurs near Hoary willow sites, although it usually takes place on established trails and not in wetlands. OHVs can drive over plants and cause hydrological alterations in their tracks. Ratings should be adjusted upwards if new trails or increased activity are reported.

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Comments
6.2	War, civil unrest, & military exercises					Not applicable.
6.3	Work & other activities					Not applicable.
7	Natural system modifications	Unknown	Pervasive	Unknown	High	
7.1	Fire & fire suppression	Unknown	Pervasive	Unknown	High	Information about natural fire regimes in the Black River system is lacking, and fire could have positive or negative effects. In general, fire is an important natural disturbance in boreal fen systems, maintaining open wetland conditions that benefit species like Hoary willow, and fire suppression can reduce suitable habitat by allowing encroachment by woody vegetation and effects on hydrology (Decker 2006). Conversely, a rare catastrophic fire could damage or destroy Hoary willow plants. More research is needed to understand the role of fire in Hoary willow habitat.
7.2	Dams & water management/use					Not applicable.
7.3	Other ecosystem modifications					Not applicable.
8	Invasive & other problematic species & genes	Unknown				
8.1	Invasive non-native/alien species	Negligible	Negligible	Slight	High	A single clump of purple loosestrife (*Lythrum salicaria*) was found in one of the Hoary willow fens in 2018 and removed. The site should be monitored for additional plants

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Comments
						that may arise from rootstock or seed. Other invasive plants such as Glossy buckthorn (*Frangula alnus*), Common reed (*Phragmites australis* spp. *australis*) and Woodland angelica (*Angelica sylvestris*) could pose a potential threat in the future.
8.2	Problematic native species	Unknown	Large	Unknown	High	Limited browsing and beaver activity have both been observed in Hoary willow habitat; however, impacts are unknown. Although browsing appeared to have little impact in Black River, research from the USA suggests that browsing can have serious consequences on Hoary willow (Gage and Cooper 2005). Localized impacts of beaver could also be significant but could be positive or negative depending on many factors (e.g. dams upstream vs. downstream) (Levine and Meyer 2019). It is possible Hoary willow has coexisted with beavers for many years, but more information is needed.
8.3	Introduced genetic material					Not applicable.
8.4	Problematic species / diseases of unknown origin					Not applicable.
8.5	Viral / prion-induced diseases					Not applicable.

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Comments
8.6	Diseases of unknown cause					Not applicable.
9	Pollution	Low				
9.1	Household sewage & urban wastewater					Not applicable.
9.2	Industrial & military effluents					Not applicable.
9.3	Agricultural & forestry effluents	Low	Small	Slight	High	Farming in the area surrounding Hoary willow populations is small-scale and mainly consists of grazing rather than high production crops. Pesticide use is likely very limited but could include annual application of glyphosate, for example. More information is needed about the extent and type of farming in the watershed.
9.4	Garbage & solid waste					Not applicable.
9.5	Air-borne pollutants					Not applicable.
9.6	Excess energy					Not applicable.
10	Geological events					Not applicable.
10.1	Volcanoes					Not applicable.
10.2	Earthquakes/tsunamis					Not applicable.
10.3	Avalanches/landslides					Not applicable.
11	Climate change & severe weather	Unknown				
11.1	Habitat shifting & alteration	Unknown	Pervasive	Unknown	High	Climate change is potentially the most serious threat to Hoary willow in Nova Scotia; however, its effects

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Comments
						and severity in the Black River system are uncertain. Hoary willow is adapted to a specific set of hydrological conditions and widespread changes to factors such as temperature, hydrology, local nutrient and moisture availability, and shifts in dominant vegetation could have a significant impact.
11.2	Droughts					Not applicable (covered in 11.1)
11.3	Temperature extremes					Not applicable (covered in 11.1)
11.4	Storms & flooding					Not applicable (covered in 11.1)

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

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

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

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

4.2 Description of Threats

The current known distribution of Hoary willow in Nova Scotia is restricted to five relatively small, isolated fens and, to a lesser extent, floodplains in the Black River watershed near Lake Ainslie in Cape Breton. The fens are moderately covered in shrubs and small trees and surrounded by woodlands. The species' apparent adaptation to wet soils and seasonal flooding suggests that any activities that alter hydrological conditions represent the foremost threat to the population. Conversely, Hoary willow is a shade-intolerant species that depends on localized disturbance events to maintain open habitats for establishment, and some threats such as altered fire regimes or beaver activity may have both negative and positive effects. The history and nature of natural disturbances in the area is poorly understood, making some threats difficult to evaluate.

Based on available information, threats to Hoary willow in Nova Scotia include agricultural activities (e.g., grazing, effluents), logging and wood harvesting, OHV activities and invasive species. Other potentially significant threats with unknown consequences include fire and fire suppression, wildlife grazing, beaver activity, and habitat shifting due to climate change; more research is needed to understand their impacts on Hoary willow. Additional future threats include fracking and peat mining, both of which have potential to occur in the longer term (>10 years) and could have far-reaching effects in the Black River watershed. It should be noted that although the risks of some individual threats to Hoary willow may be low, the restriction of the entire Nova Scotia population to a very small area within the same watershed increases its vulnerability as some of the threats could impact all known sites with disastrous consequences. The overall threat impact for Hoary willow is Medium. The overall threat impact considers the cumulative impacts of multiple threats. A description of each threat is provided below, in order of decreasing level of concern.

Agriculture & Aquaculture – Livestock Farming & Ranching (Low)

There does not appear to be any extensive agricultural activity in the Black River watershed; however, at least two of the fens containing Hoary willow appear to be adjacent to current or perhaps past small farming activities, and some localized grazing by livestock does occur. Limited browsing of Hoary willow was noted during fieldwork conducted for the Update Status Report (Nova Scotia Department of Lands and Forestry 2021) although it is unknown whether browsing was by livestock or wildlife. Moderate grazing by livestock could have some beneficial effects (e.g., by spreading seeds, encouraging re-growth) but more information is needed. Livestock grazing is listed as a threat to Hoary willow in rich calcareous fen habitat in some states in the USA (Decker 2006).

Biological Resource Use – Logging & Wood Harvesting (Low)

There is not much harvestable wood mixed in with Hoary willow and current regulations restrict logging activities in wetlands (e.g. *Wildlife Habitat and Watercourses Protection Regulations*). However, there has been some evidence of logging being considered

nearby (e.g., spray paint on trees; flag lines) and there is potential for small-scale harvesting on private land. In 2010, two botanists from the AC CDC noted survey lines that suggested future forest harvest activity on the slopes near one of the Hoary willow fens (Newell 2010). As most of the wooded areas surrounding the fens are on slopes, harvesting under the current forestry guidelines could impact runoff and the water table in the adjacent fens. Additionally, forestry equipment could drive over or damage Hoary willow plants. Field work conducted in 2018 for the Update Status Report (Nova Scotia Department of Lands and Forestry 2021) revealed that no clearcutting had taken place in the vicinity. However, forest harvesting remains a potential threat to most of the fen populations of Hoary willow.

Human Intrusions & Disturbance – Recreational Activities (Low)

Limited OHV activity currently occurs near Hoary willow sites, usually on established trails and not in wetlands. During field work conducted in 2018 for the Hoary willow Update Status Report (Nova Scotia Department of Lands and Forestry 2021), only a very small amount of OHV activity was observed in one or two of the fens associated with the species. OHVs were observed on the rail trail near some of the populations. It is unknown at this time what impact OHV use would have on Hoary willow. Potentially light to medium OHV use in and around the fens may reduce competition from other species and create openings for seedlings to develop. However, OHV use could also damage or destroy adult plants, cause hydrological alterations in their tracks, and provide pathways for invasive species to establish within Hoary willow habitat. OHV use should be monitored as new trails or increased activity could change the threat level.

Pollution – Agricultural & Forestry Effluents (Low)

Although there is no large-scale commercial agriculture in the Black River watershed, it is likely that some pesticide and fertilizer use is associated with small-scale operations. Potential runoff from, or the flooding of agricultural fields could increase nutrient input in Hoary willow fens and have a negative impact by increasing competition from other plant species. Although chemical spills are unlikely, a single spill could negatively impact the entire population of Hoary willow in the province. More information is needed about agriculture and chemical use in the watershed, particularly since water quality changes could have a widespread negative impact on the species.

Invasive & Other Problematic Species & Genes – Invasive Non-native Species/Alien Species (Negligible)

There are a number of invasive species present in Nova Scotia that could invade the fen areas in the Black River watershed; however, the only invasive species discovered to date was a single clump of Purple loosestrife (*Lythrum salicaria*) found in one of the fens in 2018 (Nova Scotia Department of Lands and Forestry 2021). Purple Loosestrife is a serious invader of wetlands in North America. The plant was removed at the time it was discovered, but this particular area should be monitored in future years for additional plants which could arise from a rootstock or from seeds. Other invasive plants that impact wetlands should be on the watch list for this area including: Glossy

buckthorn (*Rhamnus frangula*), Common reed (*Phragmites australis spp. australis)* and Woodland Angelica (*Angelica sylvestris*), among others.

Natural System Modifications – Fire & Fire suppression (Unknown)

Most of Nova Scotia's Hoary willow is located in moderately densely vegetated fens that are apparently still open enough to allow adult plants to survive. However, as no seedlings have been observed, the habitat may be too dense for seed propagation. *(It is also possible that seedlings were missed during surveys).* Most of the plants appear to propagate asexually by layering (developing roots where outlying branches touch the ground) generally forming a loose clump. The fen habitats may be closing in through succession, resulting in increased shading of the willows. Argus (2006) indicates that willows are shade intolerant and will decline as habitats become stabilized and invaded by taller vegetation. This may also explain the lack of seedlings observed in the fens as Argus (2006) also states that willows growing in a habitat with a closed ground cover such as a fen or bog cannot easily reproduce by seed in the same place unless there is some disturbance.

Wildfire suppression may have had an impact on these processes. Fire is an important natural disturbance in boreal fen systems, maintaining open wetland conditions that benefit species like Hoary willow, and fire suppression can reduce suitable habitat and affect hydrology (Decker 2006). Willows are reported to have some tolerance to fire (Cremer 2003), so with the absence of fire to disrupt the succession process, encroachment and shading by successional species may continue, potentially eliminating seedling growth (this may already be happening) and possibly the growth of adult plants. However, information about natural fire regimes in the Black River system is lacking, and it is unclear what role fire may have historically played in natural successional processes. By contrast, fire could have negative impacts as a rare catastrophic fire could damage or destroy Hoary willow plants (Decker 2006). Fire return intervals for boreal fen systems are generally long (Decker 2006) and recent estimates put natural return intervals for Nova Scotia at >150 years (Taylor et al. 2020) but detailed historical information on local fire frequency and severity is not available. More research is needed to understand the role of fire in Hoary willow habitat.

Invasive & Other Problematic Species and Genes – Problematic Native Species/Diseases (Unknown)

There are two wildlife-related potential threats to the Hoary willow population. These are grazing and beaver dam establishment. During field work conducted for both the original status report (Newell, 2010) and the Update Status Report (Nova Scotia Department of Lands and Forestry 2021) only limited browsing on Hoary willow was noted. This was probably Moose although White-tailed deer, Snowshoe hare and domestic livestock are also a possibility. Although there appeared to be little impact on the Hoary willow populations, research by Gage and Cooper (2005) in Rocky Mountain National Park, Colorado, USA, found that sustained and intense browsing of riparian shrub willows by elk had a profound effect on the spatial distribution and abundance of Hoary willow seeds, reducing the probability of seeds reaching suitable sites for germination.

Browsing removes leaves as well as stems on which aments would be produced, thereby reducing or even eliminating flower and seed production. Livestock grazing is also listed as a threat to Hoary willow in rich calcareous fen habitat in some states in the USA (Decker 2006).

Also noted during fieldwork carried out for the Update Status Report (Nova Scotia Department of Lands and Forestry 2021), two beaver dams were located in close proximity to one Hoary willow site. Beavers are widely recognized as ecosystem engineers, and beaver dams can potentially alter the hydrological regime of nearby fen habitat (Washington State Department of Natural Resources 2018; Levine and Meyer 2019). Beaver activity involves dam building, riparian plant browsing and dam abandonment, all of which can affect hydrology, sediment storage and riparian vegetation in a complex cycle of natural disturbance that could have positive or negative effects on Hoary willow depending on many factors (Levine and Meyer 2019). It is possible Hoary willow has co-existed with beavers throughout its history in the Black River watershed; however, its restricted distribution could also make it vulnerable to flooding events or other changes in water levels. More information is needed to understand the role of beaver activity in Hoary willow habitat, and beaver activity should be monitored for any significant changes.

Climate Change & Severe Weather – Habitat shifting & alteration (Unknown)

Climate change is potentially the most serious threat to Hoary willow in Nova Scotia, however its effects and severity in the Black River system are uncertain. Hoary willow in Nova Scotia's Black River fens and river floodplains is adapted to a specific set of hydrological conditions; it is subject to seasonal flooding or at least soil saturation that potentially reduces competition and is considered to be a stress tolerator, growing in water-logged soils at low temperatures (Decker 2006). In addition, willow seed can germinate both on and underwater. The seedlings can survive under water for up to a month, although continued survival requires exposure to air (Cremer 2003). Willow seeds are considered non-dormant and short-lived and require specific moisture and light conditions for germination and survival; they have a limited window in which to find suitable habitat and experience high mortality if those conditions are not met (Argus 2006).

Widespread changes to factors such as temperature, hydrology, local nutrient and moisture availability, and shifts in dominant vegetation could all have a significant impact on Hoary willow, for example by reducing seedling viability or increasing competition from upland plant species. In particular, as an obligate wetland species with boreal affinity, Hoary willow may not be able to withstand long-term drought conditions and may also be at risk from extreme (hot) temperatures during summer. In addition, while the species is adapted to flooding, extreme storm events could lead to erosion that could affect individual plants. The unpredictable nature of climate change effects at the local scale make the associated threats difficult to predict but many of them could have population-wide implications.

Energy Production & Mining – Oil & Gas Drilling (Not calculated; outside of assessment timeframe)

The Black River system is located within a region where there has been interest in oil and gas exploration by means of fracking (hydraulic fracturing). Fracking is the injection of fluid into shale beds at high pressure to free up petroleum resources. In 2010, an oil and gas exploration company were able to obtain 100% exploration and development rights over an area of 155,300 ha surrounding Lake Ainslie, including the Black River watershed. Any fracking carried out within the watershed could potentially have serious negative impacts on populations of Hoary willow as well as the other rare plant species within this system by altering hydrology and/or by introducing toxic chemicals into the environment (e.g., see Kiviat 2013).

Due to intense community pressure, the Inverness County Council passed the first bylaw banning fracking in Canada in May 2013. The oil and gas company did not proceed with drilling and the company's lease expired on July 15, 2013 (The Council of Canadians 2013). In 2014, the Government of Nova Scotia placed a moratorium on fracking in the province because of potential negative environmental impacts. However, pressure on politicians to allow fracking in the province based on potential economic benefits remains high. This pressure is likely to increase in the future since Nova Scotia's offshore supply is expected to run out by 2020 (Withers 2018) and there are increased costs associated with bringing natural gas into the province by pipeline. The possibility of future interest and activity with respect to oil and gas exploration and extraction in the Black River area of Cape Breton should be monitored as there is always the possibility that the moratorium could be lifted and municipal bylaws changed.

Energy Production & Mining – Mining & Quarrying (Not calculated; outside of assessment timeframe)

Some areas within the Black River system have been identified as having deposits of moss and fuel grade peat (Anderson and Broughm 1988). A substantial peat moss industry exists in Eastern North America with the bulk of production used for horticultural purposes (as a soil amendment or growing medium) and other uses including distillation, yeast cultivation, energy production and manufacture of ferrosilicons. About 90% of Canada's peat export is to the United States, with most of the remainder going to Europe and Japan and interest in North American peat is growing (Anderson 1993). Peat mining may prove to be a future potential threat. Peat mining on fens/bogs that do not contain Hoary willow but are still in the same watershed can impact the water table associated with fens that do contain Hoary willow.

5. POPULATION AND DISTRIBUTION OBJECTIVES

5.1 Viable Status for Recovery

Hoary willow occurs in a very limited area in just one watershed in Nova Scotia, making it vulnerable to a number of threats which could potentially impact or eliminate the entire

population. Given the lack of information about historical population and distribution sizes, it is unclear whether it was previously more widespread or abundant in the province. To obtain viable status for recovery in the future, intended as a long-term goal of removing it from the NSESA, it would need to become established more widely, i.e., in separate watersheds so that all plants are not subject to the same threats. However, research is needed to address significant knowledge gaps and determine whether this is a feasible and recommended course of action. It is possible that Hoary willow is naturally rare in Nova Scotia and will always be naturally limited to the Black River watershed; as such, the measures outlined in this document to reduce or eliminate threats, may not result in de-listing of the species.

The long-term recovery goal (>20 years) for Hoary willow is to maintain and promote conditions that allow for a self-sustaining and ecologically functioning population within the province. A population and distribution objective that reflects the best achievable scenario is to: (1) increase the Hoary willow population within the Black River watershed and (2) consider experimental planting in suitable habitat elsewhere. Projected numbers of individuals are not determined at this time but should reflect an increase from current estimates of 1300-1600 individuals over 20 years, subject to further research on reproductive biology, genetics, ecological requirements, and habitat availability.

5.2 Short-term population and distribution objective

The short-term population and distribution objective for Hoary willow is to maintain current numbers of at least 1300-1600 individuals at existing sites in the Black River watershed (i.e., no decrease in numbers of individuals or sites) over five years. Experimental planting in adjacent and/or nearby marginal habitat that might be able to support the species should also be considered, to support the long-term goals above.

5.3 Rationale

Population and distribution objectives assist with the identification of activities needed for recovery, and for Hoary willow are based on the best information in this document as well as the most recent Update Status Report (Nova Scotia Department of Lands and Forestry 2021). Surveys performed for the Update Status Report in 2018 offer the most accurate population assessment to date of 1300-1600 individuals which represents a slight decline from 2010 (Newell 2010). Prior to 2010, there are no detailed historical data on which to base population trends.

The short-term population and distribution objective of maintaining current numbers of individuals and sites in the Black River watershed (i.e., no loss of # individuals or sites) over five years aims to prevent further population decline, while allowing for some landscape-wide natural fluctuation. An additional goal is to initiate research to support habitat modelling and experimental planting in the Black River watershed to increase the size of the existing population and provide a foundation for possible out-planting in

other unconnected watersheds in future. As stated above, the long-term recovery goal of establishing Hoary willow outside the Black River watershed will require research and careful planning to determine the feasibility and advisability of expanding its distribution into new habitats.

6. BROAD STRATEGIES AND GENERAL APPROACHES TO RECOVERY

6.1 Actions Completed or Underway

- Targeted fieldwork for Hoary willow has been conducted as follows. All surveys were conducted by foot. A canoe was used to access two of the three fen sites occurring along the Black River.
    - 4 field days by Ruth and Reg Newell in 2010.
    - 1 field day conducted by AC CDC in 2010.
    - 2 field days conducted by AC CDC in 2015.
    - 2 field days conducted by AC CDC in 2018
    - 4 field days by Ruth and Reg Newell in 2018.
- Targeted field work for Hoary willow was also conducted in the two Rivers Wildlife Park, Huntington, Cape Breton in an effort to relocate the original collection site and/or the species from herbarium specimens.
    - 1 field day by Ruth and Reg Newell in 2010.
    - No field days at this location were performed in 2018.
- A provincial Status Report was prepared for Hoary willow in 2010 (Newell 2010) and an Update Status Report in 2018 (Nova Scotia Department of Lands and Forestry 2021).
- Hoary willow was assessed by the Nova Scotia Species at Risk Working Group and listed as Endangered under Nova Scotia's *Endangered Species Act* in 2013.
- Many of the Black River properties with Hoary willow occurrences are privately owned. Lands near the mouth of the Black River were designated as Black River Bog Nature Reserve (~109 ha) in 2015. None of the current known Hoary willow sites fall within the reserve, but two historic records of Hoary willow from AC CDC are within the nature reserve area (See Update Status Report for more information).

- The Nature Conservancy of Canada (pers. comm., 2018) has acquired property within the Black River watershed. Parts of two fens and one marsh containing Hoary willow fall within this property.

- In 2012, 2014 and 2015, the AC CDC conducted extensive biodiversity surveys in Nova Scotia's gypsum- and limestone-associated habitats. Mainly funded through the Nova Scotia Crown Share Land Legacy Trust, these fieldwork efforts collectively involved the detailed survey of over 90 karst sites throughout the geographic range of Nova Scotia's gypsum occurrences, from western Hants County to northern Cape Breton. Although many of the surveys specifically targeted fens underlain by gypsum and limestone containing habitat suitable for Hoary willow, including a number of sites around Lake Ainslie (e.g., Hays River, Strathlorne Station), no new occurrences were discovered.

6.2 Options for Recovery

The following table (Table 3) summarizes recovery actions and specific steps recommended to address threats and achieve successful recovery of Hoary willow in Nova Scotia, along with their priority and approximate costs.

Table 3. Recovery options planning table.

Recovery Measures	Threats Addressed*	Actions	Priority**	Cost***	Benefit
Habitat Protection, Management and Stewardship					
Protect Hoary willow habitat, especially land with or near known occurrences through land purchase and conservation easements.	2.3, 3.1, 3.2, 4.1, 5.3, 6.1, 7.1, 8.1, 8.2, 9.3	• Develop stewardship agreements with private landowners in Hoary willow habitat. • Incentivize the protection of private lands. • Consider outright purchase/leasing of the fens and a surrounding buffer through government, or partnerships with land trusts. • Provide opportunities for landowners to make ecological land donations or, if they wish to retain the land, enter into conservation agreements.	H	$$$$	Habitat protection and enhancement; threat reduction; stakeholder investment in SAR recovery.
Evaluate a long-term conservation strategy to augment Hoary willow population and establish the species outside the Black River system.	All threats	• Develop capacity to preserve local genetic material for Hoary willow and to propagate this species successfully. • Collect and preserve Hoary willow seeds and/or material in order to support future restoration efforts if required. • Consider experimental outplanting of specimens or manual dispersal of seeds in new areas with suitable habitat.	M	$	Increase in population size; increase in suitable habitat; long-term storage of genetic material.
Surveys and Monitoring					

Conduct ongoing monitoring of Hoary willow sites.	All threats	• Develop a monitoring plan with standardized survey approaches and timelines. • Conduct monitoring of known Hoary willow sites and gather baseline data to assess population dynamics. • Delineate wetlands in the Black River system. • Establish baseline measurements of site and habitat parameters and monitor to record changes over time.	H	$	Population and distribution knowledge to support recovery actions.
Conduct surveys to identify and track threats such as beaver activity, grazing, OHV use and invasive species.	All threats	• Conduct regular monitoring of the Hoary willow fens to increase awareness of any beaver, grazing, OHV or other disruptive activities that may have a negative impact. • Conduct regular monitoring for Purple loosestrife or any other potential invasive species.	H	$	Increased knowledge of threats and their impacts; early warning of serious impacts.
Conduct surveys of potential sites to identify possible new occurrences of Hoary willow.	All threats	• Conduct surveys of high-potential sites where Hoary willow may occur but has not been documented; a search for new sites could uncover populations in more open habitat that harbour seedlings as well as adult plants.	M	$	Population and distribution knowledge to inform recovery planning process.
Communication, Outreach and Education					
Increase landowner awareness about the presence and status of Hoary willow on private land.	2.3, 3.1, 3.2, 4.1, 5.3, 6.1, 8.1, 8.2, 9.3	• Develop information resources (e.g., factsheets, handouts, best management practices) summarising information about the ecology of Hoary willow and what activities are beneficial or harmful. • Provide information to landowners in relevant areas (i.e., core habitat and surrounding watershed) to inform them about species present on their lands and their responsibilities as landowners with SAR.	H	$	Habitat protection and enhancement; increased awareness and public engagement; stakeholder investment in SAR recovery.

		• Attach informative statement and relevant contact information to transactional processes such as property deeds and permit applications.			
Define/clarify responsibilities of various agencies to aid in the protection of Hoary willow.	2.3, 3.1, 3.2, 4.1, 5.3, 6.1, 7.1, 8.1, 8.2, 9.3	• Define responsibilities and communication pathways between provincial, municipal and non-governmental organizations responsible for the management of land on which core habitat occurs. • Provide detailed information to relevant agencies about Hoary willow distribution, ecology and conservation.	M	$	Habitat protection and enhancement; increased cooperation and efficiencies.
Provide information to Municipality about their responsibility to assist in the protection of Hoary willow.	2.3, 3.1, 3.2, 4.1, 5.3, 6.1, 7.1, 8.1, 8.2, 9.3	• Coordinate with Municipality of Inverness to promote awareness and protection of Hoary willow on private lands. • Encourage incorporation of SAR restrictions into municipal development plans.	M	$	Habitat protection and enhancement; stakeholder investment in SAR recovery.
Law, Policy and Enforcement					
Core habitat requirements and considerations.	2.3, 3.1, 3.2, 4.1, 5.3, 6.1, 7.1, 8.1, 8.2, 9.3	• Define and designate core habitat under the *Nova Scotia Endangered Species Act.* • Work to eliminate threats on Crown lands with known occurrences and develop Special Management Practices for Hoary willow.	H	$	Habitat protection; threat reduction.
Enforce legislation and policies related to resource extraction and other development activities in core habitat.	2.3, 3.1, 3.2, 4.1, 5.3, 6.1, 7.1, 8.1, 8.2, 9.3	• Ensure the continued restrictions of fracking activities that may impact the Black River watershed. • Ensure peat mining is not permitted within the Black River watershed to prevent impacts on the water table.	H	$	Habitat protection; threat reduction.
Research to Address Knowledge Gaps					
Form research partnerships with local governments, universities,	All threats	• Form partnership(s) to conduct research on the biology, habitat or	H	$	Increased cooperation and

and non-governmental organizations.		ecological requirements of Hoary willow and on alkaline wetlands in Nova Scotia.			efficiencies to fill knowledge gaps.
Conduct research on Hoary willow biology and ecology.	All threats	• Conduct research on Hoary willow population and reproductive biology including seed viability and dispersal, relative importance of sexual vs. vegetative reproduction in Nova Scotia and what comprises an "individual". • Determine genetic relationships within and between Hoary willow populations in Nova Scotia and elsewhere (e.g., PEI, NB). • Research viable methods for long-term storage of Hoary willow seeds/plant propagation. • Evaluate experimental germination and/or propagation trials to refine techniques to support outplanting.	H	$$	Increased population and distribution knowledge to support recovery planning.
Conduct research on Hoary willow habitat requirements.	All threats	• Conduct research on Hoary willow habitat including hydrology, water quality, soil properties, fungal associations and site characteristics. • Conduct habitat manipulation studies such as creating areas of disturbed ground, determining seed viability/seed bank storage techniques and determining sensitivity to hydrological fluctuations. • Characterize ecological amplitude to evaluate the need for outplanting.	H	$$	Increased population and distribution knowledge to support recovery planning.
Conduct habitat modelling for Hoary willow and assess habitat suitability in currently unoccupied lands.	All threats	• Conduct habitat modelling based on wetland mapping/hydrology, geology, tree/shrub cover (using aerial imagery and/or LIDAR) and indicator species from the AC CDC database. • Assess habitat availability of potentially suitable new areas (e.g.,	M	$$	Potential increase in suitable habitat.

		hydrology, calcium, water temperature). • Conduct surveys to identify sites outside the Black River system where transplanting could be used to expand the distribution of Hoary willow into new suitable habitats.			
Assess effects of threats such as beaver dams, grazing, OHV activities, etc.	2.3, 4.1, 5.3, 6.1, 7.1, 8.1, 8.2, 9.3	• Conduct multi-year surveys to assess the effects of threats on Hoary willow. • Study impacts of beaver dams and monitor for rebuilding activities or flooding. • Consider mitigation measures if necessary, e.g., vegetation removal/control to allow for ecological succession and the persistence of Hoary willow.	M	$$	Increased understanding of threats; threat reduction.
Increase research and educational outreach on the impacts of climate change on SAR such as Hoary willow.	11.1, 11.2	• Conduct research on temperature and drought sensitivity of seedlings and adults. • Incorporate results into outreach materials for local landowners, conservation groups, etc.	L	$$	Increased understanding of threats.

* Threat or Limitation should refer to the IUCN Threat Classification Table Rankings. Either the first level or second level threat ranking can be used depending on how the Broad Strategy affects the threat. Multiple threats can be addressed under a single Recovery Measure.

**Priority should be classified as High(H), Medium(M), or Low(L). “Priority” is a qualitative measure of the relative degree to which an approach will have a positive impact on the recovery objective. High priority conservation approaches are considered those most likely to have an immediate and/or direct influence on reaching the management objective for the species. Medium priority conservation approaches may have a less immediate or less direct influence on reaching the management objective but are still considered important measures to implement. Low priority conservation approaches will likely have an indirect or gradual influence on reaching the management objective and are more tied to increasing knowledge or public perception/education.

***Use the following to assign a cost estimate to proposed activities: $ = < 10 000; $$ = 10 000-50 000; $$$ = 50 000-100 000; $$$$=>100 000-1,000,000, $$$$$ >1,000,000.

6.3 Narrative to Support the Recovery Options Planning Table

The recovery of Hoary willow will require several categories of actions to protect the existing population and investigate the need and feasibility of augmenting population numbers and expanding the current distribution to sites outside the Black River system. In particular, protection of land in the Black River system through purchase, leasing or conservation agreements, identifying and designating core habitat under the *Nova Scotia Endangered Species Act*, raising awareness among private landowners, and research to address significant knowledge gaps, are important priorities.

Habitat protection, management and stewardship

Habitat protection is the most direct way to support the recovery of Hoary willow and mitigate the impacts of multiple threats. The small population and isolated nature of its distribution make this particularly important. The majority of the sites where Hoary Willow occurs in Nova Scotia are relatively isolated fens or marshes within the Black River watershed. Most of the fens are small as are the areas of occurrence on the flood plains/marshes. Except for mining fuel grade peat, the fens do not appear to be of high economic value, however there may be some interest in harvesting part of the surrounding woodlands. Although the cost of this type of land is unknown at this time, outright purchase of the fens and a surrounding buffer appears to be the most efficient method to protect the Hoary willow population. These areas could either be acquired directly through government or in partnership with conservation land trusts. A partnership with conservation groups could also provide an opportunity for private landowners to make ecological land donations or, if they wish to retain the land, enter into conservation agreements. Incentivization of private land protection where possible would benefit the species and help achieve recovery objectives. In addition, landowner contact and stewardship activities could increase awareness for property owners and the general public.

Long-term leasing of the land may be another option instead of outright purchase. The fens and surrounding woodland could be leased long term (20+ years) with an opportunity to review the agreement every 10 years (or any other appropriate time period) and the potential to renew the agreement at the end of the term. A full payment of the agreement upfront should be more appealing to the landowner and reduce the paperwork for the leaser. The lease should run with the land and include the right of first refusal should the land be sold.

In addition to protecting current habitat, a long-term strategy should be developed to conserve and manage genetic material should there be a need to restore Hoary willow within its existing distribution or outside the Black River system. With all known Hoary willow sites located in one small watershed which makes it disproportionately susceptible to threats. Recovery objectives include an evaluation of the need to augment the existing population within and outside of its known distribution in suitable habitat. This requires developing capacity for preserving genetic material and experimental propagation as well as improving our understanding of ecological

amplitude and habitat requirements (see *Research to address knowledge gaps*, below).

Surveys and monitoring

Accurate baseline information is required in order to better understand Hoary willow population dynamics, and to inform decision-making processes. This is particularly important in light of the lack of historical data on which to base population trends. A standardized monitoring plan should be developed that includes methodologies and timelines for consistent population counts, as well as regular monitoring of habitat parameters and threats (e.g., water quality, beaver dams, OHV activities, road maintenance, grazing, invasive species, etc.). Data should be used to model population trends and habitat suitability and continue to refine our core habitat over time.

In addition to monitoring known sites, it is important to survey for Hoary willow in new locations. It is possible that a limited number of additional sites containing Hoary willow will be found within the Black River system (and possibly elsewhere, e.g., in the Huntington area of Cape Breton Island). With the apparent lack of seedlings within the current Hoary Willow population, the species could collapse over the next few years as the vegetation in the current sites becomes denser and taller. A search for new sites could uncover Hoary willow in more open fens that harbour seedlings as well as adult plants. The survey could be conducted as an organized 2-3 day “bio blitz” of the area by a group of botanists and other knowledgeable people. In addition to assaying the area for additional sites with Hoary willow, the surveyors could also record other rare species associated with alkaline wetlands. It should be noted however that a significant amount of survey work has already been completed in this area by the AC CDC.

Communication, outreach, and education

Communication, outreach and education are important elements in the recovery of Hoary willow in Nova Scotia, and complementary to other recovery actions. More than 80% of Hoary willow core habitat falls on private land and there is an opportunity to raise awareness among landowners, users and managers, to advance best management practices that will benefit the species. Most of the landowners in the Black River area are unaware that they have Hoary willow on their property especially given that many of the sites are not easily accessible. In addition, the plants are not showy or easily distinguishable from similar species. Most landowners in the area are also unaware of the activities that are beneficial/detrimental to the plants. For example, cutting the vegetation of the slopes surrounding some of the Hoary willow populations could change the hydrology and runoff into the wetland area potentially increasing flooding in the spring and/or dry conditions later in the summer. There may be some awareness of the uniqueness of the alkaline wetland complex associated with the Black River system within the general community surrounding the area, but it is unlikely that most of the public, and to some extent, government agencies (municipal, provincial, federal) are well informed on the matter.

In addition to informing landowners that Hoary willow occurs on their property, there is a need to provide information on the ecology of the species and what activities are

beneficial or harmful. Ideally, this could be done through a stewardship approach and a visit to the property. The visit would provide an opportunity to show the landowner where the plant occurs on their property and discuss potential conservation activities and best management practices. Development of resources such as fact sheets and handouts would support this approach.

In addition to working with landowners, it would be beneficial to develop stewardship activities to promote the conservation of Hoary Willow to the public. This would draw attention to the status of the plant, its habitat and hopefully create a connection with landowners/the public to protect this plant.

As mentioned, most landowners are unaware that there is Hoary willow (or any endangered species) on their property. One approach to ensure that landowners are aware of this is to attach a statement to transactional processes such as property deeds. This would run with the deed and all landowners, regardless of land use, would be aware that they have a species at risk on the property. Currently, there is a variety of information such as municipal development agreements or conservation easements that are attached to, and run with the deeds (Mark Fredericks, Municipal Planner, Kings County, pers comm, 2019).

More communication, support and cooperation need to be developed between provincial government agencies and municipal governments who are responsible for land use and land-based activities. Roles and responsibilities should be clarified and training activities for land-use monitors and enforcement personnel need to be undertaken on a regular basis. There is a need to provide more detailed information to the Municipality of Inverness and other appropriate provincial (and federal) agencies about Hoary willow sites and conservation. Development officers and municipal planners review development projects and home construction. Knowing that there is an endangered species on a site can flag that site so that Nova Scotia Lands and Forestry/Nova Scotia Environment can be contacted, and any necessary restrictions can be incorporated into the development plans.

Law, policy, and enforcement

Law, policy, and enforcement augments or reinforces many of the actions identified in other sections and can be achieved through the creation of new policy, improvements to pre-existing policies, and guidance to support Species at Risk recovery.

Defining and designating core habitat for Hoary willow in the Black River system would provide a legal underpinning for many of the habitat protection, stewardship and public outreach measures discussed above. Ensuring the continued enforcement of the no-fracking bylaw in Inverness County, and prohibiting peat mining in the Black River watershed are essential to protect Hoary willow from these serious threats that could potentially eliminate the entire population.

Research to address knowledge gaps

There is little scientific information available on the biology, habitat or other ecological requirements of Hoary willow or alkaline wetlands in Nova Scotia. For instance, it is not known whether viable seeds are produced, or if seeds can/do overwinter. Seed dispersal mechanisms, seedling survival requirements and an understanding of pollination biology of the flowers, as well as the relative importance of sexual vs. vegetative reproduction are also knowledge gaps. Determining if Hoary willow in Nova Scotia is genetically distinct from other populations may shed light on the evolution and biogeography of the species. Peripheral populations of a species are often genetically distinct from central populations. Preserving this genetic diversity may prove critical to the long-term survival of the species (Lesica and Allendorf 1995). Without filling in the various information gaps, the ability to assess actions for the maintenance and expansion of the Hoary willow population is very limited.

It is recommended that a partnership(s) be formed with one or more universities to increase cooperation and efficiencies in conducting research on the biology, habitat or ecological requirements of Hoary willow and on alkaline wetlands in Nova Scotia. Priority research topics include reproductive biology, ecology, genetics, and viable methods for long-term storage of genetic information. Support should be provided for seed bank storage and experimental germination and/or propagation trials to refine techniques to support outplanting if required. Research is also needed to examine the ecological amplitude and habitat requirements of Hoary willow (e.g., hydrology, water quality, soil properties, fungal associations, site characteristics, etc.) to support habitat modelling. This should include some habitat manipulation studies to determine factors such as seed viability, growth requirements for seedlings and sensitivity to hydrological fluctuations. Surveys/research to identify potential new habitat and assess the viability of establishing Hoary willow outside the Black River watershed will also be necessary.

In addition to research on Hoary willow biology, ecology and habitat requirements, there are also significant knowledge gaps with regard to the impacts of many threats. Hoary willow is a shade-intolerant species that may rely on some level of natural disturbance to create openings for germination and growth; it is unclear to what extent some threats, such as grazing, beaver dams and fire suppression may be harmful or beneficial to Hoary willow (or both). Threats must be evaluated regularly and managers consider the need for mitigation measures to support species' persistence (e.g., vegetation removal or control to re-set ecological succession). Finally, research on Hoary willow's stress response to factors such as flooding or drought should be considered to determine the possible effects of climate change and implications for survival.

6. RECOMMENDED COURSE OF ACTION(S) FOR RECOVERY

Table 4 provides the recommended course of actions for recovery of the species and the timeframe for completing these actions.

Note that recovery of species at risk is a shared responsibility and not all the actions in the table below will be carried out by the Department. Implementation will depend to a

large degree on opportunities for collaboration with other individuals and organizations, and will be subject to budget constraints, appropriations, and changing priorities.

Table 4. Recovery actions and implementation schedule.

Habitat Protection, Management and Stewardship		**Implementation Schedule**
Approach 1.1: Protect Hoary willow habitat, especially land with or near known occurrences.		
Action 1.1.1	Develop stewardship agreements with private landowners in Hoary willow habitat	2023-2031
Action 1.1.2	Assess options to incentivize the protection of private land and implement where feasible	2024-2028
Action 1.1.3	Consider outright purchase/leasing of the fens and a surrounding buffer through government, or partnerships with land trusts	Ongoing
Action 1.1.4	Provide opportunities for landowners to make ecological land donations or, if they wish to retain the land, enter into conservation agreements.	Ongoing
Approach 1.2: Evaluate and develop if appropriate, a long-term conservation strategy to augment Hoary willow population and establish the species outside the Black River system.		
Action 1.2.1	Develop capacity to preserve local genetic material for Hoary willow and to propagate this species successfully.	2021-2026
Action 1.2.2	Collect and preserve Hoary willow seeds and/or material to support future restoration efforts if required.	2022-2026
Action 1.2.3	Evaluate experimental outplanting of specimens or manual dispersal of seeds in new areas with suitable habitat.	2023-2026
Surveys and Monitoring		**Implementation Schedule**
Approach 2.1: Conduct ongoing monitoring of Hoary willow sites.		
Action 2.1.1	Develop a monitoring plan with standardized survey approaches and timelines.	2021-2026
Action 2.1.2	Conduct monitoring of known Hoary willow sites and gather baseline data to assess population dynamics.	2021-2026
Action 2.1.3	Delineate wetlands in the Black River system.	2021-2023
Action 2.1.4	Establish baseline measurements of site and habitat parameters and monitor to record changes over time.	2021-2026
Approach 2.2: Conduct surveys to identify and track threats such as beaver activity, grazing, OHV use and invasive species.		
Action 2.2.1	Conduct regular monitoring of the Hoary willow fens to increase awareness of any beaver, grazing, OHV or other disruptive activities that may have a negative impact (annually).	2021-2031
Action 2.2.2	Conduct regular monitoring for Purple loosestrife or any other potential invasive species (annually).	2021-2031
Approach 2.3: Conduct surveys of potential sites to identify possible new occurrences of Hoary willow.		
Action 2.3.1	Conduct surveys of high-potential sites where Hoary willow may occur but has not been documented; a search for new sites could uncover populations in more open habitat that harbour seedlings as well as adult plants.	2023-2026
Communication, Outreach and Education		**Implementation Schedule**
Approach 3.1: Increase landowner awareness about the presence and status of Hoary willow on private land.		

Action 3.1.1	Develop information resources (e.g., factsheets, handouts, best management practices) summarising information about the ecology of Hoary willow and what activities are beneficial or harmful.	2021-2023
Action 3.1.2	Provide information to landowners in relevant areas (i.e., core habitat and surrounding watershed) to inform them about species present on their lands and their responsibilities as landowners with SAR.	2022-2023
Action 3.1.3	Attach informative statement and relevant contact information to transactional processes such as property deeds and permit applications.	2022-2023
Approach 3.2: Define/clarify responsibilities of various agencies to aid in the protection of Hoary willow.		
Action 3.2.1	Define responsibilities and communication pathways between provincial, municipal and non-governmental organizations responsible for the management of land on which core habitat occurs.	2023-2026
Action 3.2.2	Provide detailed information to relevant agencies about Hoary willow distribution, ecology and conservation.	2023-2026
Approach 3.3: Provide information to Municipality about their responsibility to assist in the protection of Hoary willow.		
Action 3.3.1	Coordinate with Municipality of Inverness to promote awareness and protection of Hoary willow on private lands.	2023-2026
Action 3.3.2	Encourage incorporation of SAR restrictions into municipal development plans.	2023-2026
Law, Policy and Enforcement		**Implementation Schedule**
Approach 4.1: Core habitat requirements and considerations.		
Action 4.1.1	Designate core habitat under the *Nova Scotia Endangered Species Act*.	2021-2026
Action 4.1.2	Work to restrict threatening activities on Crown lands with known occurrences and develop Special Management Practices for Hoary willow.	2021-2023
Approach 4.2: Enforce legislation and policies related to resource extraction and other development activities in core habitat.		
Action 4.2.1	Ensure the continued restrictions of fracking activities that may impact the Black River watershed.	Ongoing
Action 4.2.2	Ensure peat mining is not permitted within the Black River watershed to prevent impacts on the water table.	Ongoing

Research to Address Knowledge Gaps		Implementation Schedule
Approach 5.1: Form research partnerships with local governments, universities, and non-governmental organizations.		
Action 5.1.1	Form partnership(s) to conduct research on the biology, habitat or ecological requirements of Hoary willow and on alkaline wetlands in Nova Scotia.	Ongoing
Approach 5.2: Conduct research on Hoary willow biology and ecology.		
Action 5.2.1	Conduct research on Hoary willow population and reproductive biology including seed viability and dispersal, relative importance of sexual vs. vegetative reproduction in Nova Scotia and what comprises an "individual".	2021-2026
Action 5.2.2	Determine genetic relationships within and between Hoary willow populations in Nova Scotia and elsewhere (e.g., PEI, NB).	2023-2026
Action 5.2.3	Research viable methods for long-term storage of Hoary willow seeds/plant propagation.	2021-2022
Action 5.2.4	Provide support for experimental germination and/or propagation trials to refine techniques to support outplanting.	2021-2026
Approach 5.3: Conduct research on Hoary willow habitat requirements.		
Action 5.3.1	Conduct research on various aspects of Hoary willow habitat including hydrology, water quality, soil properties, fungal associations and site characteristics.	2022-2031
Action 5.3.2	Conduct habitat manipulation studies such as creating areas of disturbed ground, determining seed viability/seed bank storage techniques and determining sensitivity to hydrological fluctuations.	2022-2031
Action 5.3.3	Characterize ecological amplitude to support outplanting.	2023-2026
Approach 5.4: Conduct habitat modelling for Hoary willow and assess habitat suitability in currently unoccupied lands.		
Action 5.4.1	Conduct habitat modelling based on (1) wetland mapping/hydrology, (2) geology, (3) tree/shrub cover (using aerial imagery and/or LIDAR) and (4) indicator species from the AC CDC database.	2021-2026
Action 5.4.2	Assess habitat availability of potentially suitable new areas (e.g., hydrology, calcium, water temperature).	2026-2031
Action 5.4.3	Conduct surveys to identify new suitable habitats outside the Black River system	2026-2031
Action 5.4.4	Consider experimental outplantings based on the best available knowledge of Hoary willow biology and ecology.	2030-2031
Approach 5.5: Assess effects of threats such as beaver dams, grazing, OHV activities, etc.		
Action 5.5.1	Conduct annual site check-ins to assess threats on Hoary willow.	2022-2031
Action 5.5.2	Study impacts of beaver dams and monitor for rebuilding activities or flooding.	2022-2031
Action 5.5.3	Consider mitigation measures if necessary, e.g., vegetation removal/control to allow for ecological succession and the persistence of Hoary willow.	2022-2031
Approach 5.6: Increase research and educational outreach on the impacts of climate change on SAR such as Hoary willow.		
Action 5.6.1	Conduct research on temperature and drought sensitivity of seedlings and adults.	2022-2031
Action 5.6.2	Incorporate results into outreach materials for local landowners, conservation groups etc.	2022-2031

7. IDENTIFICATION OF CORE HABITAT

Under the *Nova Scotia Endangered Species Act;* core habitat is defined as "specific areas of habitat essential for the long-term survival and recovery of endangered or threatened species and that are designated as core habitat pursuant to Section 16 or identified in an order made pursuant to Section 18". A definition for Hoary willow core habitat is included here using the best available information at the time of writing; however, given the knowledge gaps and anticipated increases in our collective knowledge of this species' needs in Nova Scotia, this definition should be updated as soon as new information is available.

7.1 Core Habitat Identification and Attributes

The restricted distribution of Hoary willow in Nova Scotia and the need to protect known sites as well as the surrounding woodlands, wooded slopes and adjacent river floodplain suggests that core habitat designation with respect to this species is vital. Because the Black River area harbours the only known occurrences of Hoary willow in Nova Scotia, core habitat has been drawn to include all known sites supporting Hoary willow as well as the surrounding wetland.

Core habitat for Hoary willow is identified as all known occurrence points with a locational uncertainty of 100 m or less, and associated wetlands within the Black River catchment, with a 100 m buffer. The buffer is applied to individual occurrence points to account for locational uncertainty, and to the wetland boundary to account for uncertainty around the impacts of threats in riparian areas and the accuracy of available wetland mapping. The size of the buffer is based on literature indicating that 100 m is a standard for protecting a variety of wetland ecological and habitat values (e.g., Faber-Langendoen et al. 2006; Environmental Law Institute 2008; Beacon Environmental Ltd. 2012). Delineation of core habitat is considered to be dynamic rather than static and mapping will need to be updated periodically as factors such as population dynamics and location of known occurrences can be expected to change over time.

In summary, core habitat for Hoary willow can be identified based on the following criteria (maps included in Appendix 1):

- Known occurrences (i.e., all known occurrences with locational uncertainty of 100 m or less, as identified in Nova Scotia Provincial Update Status Report; Nova Scotia Department of Lands and Forestry 2021);
- Associated wetlands (i.e., continuous wetlands containing Hoary willow) in the Black River sub-tertiary watershed, delineated based on available GIS wetland layers (e.g., Nova Scotia Department of Lands and Forestry 2007; 2020);
- 100 m buffer around each occurrence point and around the wetland boundary.

7.2 Activities Likely to Result in the Destruction of Core Habitat

Destruction of Hoary willow core habitat would result if part of the habitat was degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from single or multiple activities at one point in time or from the cumulative effects of one or more activities over time and must be determined on a case by case basis.

Activities likely to result in destruction might occur within the core habitat but might also occur outside of the core habitat. Activities that are likely to result in the destruction of Hoary willow core habitat include but are not limited to:

- Activities that result in alterations to the water table, such as:
  - Ditching for farming practices to allow for drainage of wetlands and land reclamation;
  - Forest activities such as logging and wood harvesting;
  - Road construction or expansion and maintenance of existing roads, trails and associated infrastructure (e.g., bridges, culverts);
  - Fracking;
  - Peat mining;
- Off highway vehicle use, which may destroy plants, impact establishment of seedlings and introduce invasive species into Hoary willow habitat;
- Agricultural activities such as livestock grazing that could damage or destroy plants;
- Pollution, including effects from indiscriminate use of fertilizers and pesticides, and;
- Introduction of invasive species such as purple loosestrife and others.

7.3 Habitat Protection / Ownership

The rich calcareous fens and marshes in which Hoary willow occurs in the Black River system are mostly privately owned. Parts of two fens and one marsh area have recently been acquired by the Nature Conservancy of Canada. One marsh population occurs on provincial Crown land. Some graminoid marsh habitat and one heavily treed wetland falls within the Black River Bog Nature Reserve (designated by the province of Nova Scotia in 1989). Two to three older specimen records for Hoary willow exist from the reserve area but their exact locations are unknown.

The area identified as core habitat for Hoary willow in this document consists of approximately 86% private land and 14% provincial crown land. Of the privately owned land, 10% is owned by the Nature Conservancy of Canada, 7% by a private company and the remaining 66% by private individuals.

8. MEASURING PROGRESS

8.1 Performance Indicators

The performance indicators identified below are a means by which progress towards population and distribution objectives can be measured. Progress will be assessed during the 5-year review process of the Recovery Plan. Performance will be assessed through the completion of actions identified under Table 5 of Section 7, *Recommended Course of Action(s) for Recovery*.

Table 5. Performance measures used to determine whether Hoary Willow recovery objectives are being met.

Performance Measure	Check-In
Planning:	
At least one Recovery Team meeting annually to discuss recovery activities and assess performance to date	Annually
Number of initiatives and groups involved in delivering conservation messaging	Annually
Assign and support individuals or teams to recovery-related projects as identified in recovery actions (Table 4)	Annually
Conservation:	
Number and type of communication products that target private landowners, general public, government and others as identified in recovery actions (Table 4)	Annually
Known sites and population maintained	Every five years
Increased percentage of core habitat protected	Every five years
Percentage of knowledge gaps addressed by published research	Every five years
All governmental permitting or approval processes that can address a threat to this species be fully implemented	Annually
Number of new Hoary willow records or documented effort to survey for new occurrences	Every ten years
Successful *ex situ* propagation of Hoary willow from Nova Scotia material	In five years

8.2 Monitoring

A Hoary willow monitoring plan is aimed at providing consistent data over time to assess population dynamics, habitat parameters and threats in Nova Scotia on an ongoing basis. The overall strategy involves monitoring known sites annually for threats, succession and changes on the landscape, with a full population count conducted every 5 years. Hoary willow is a perennial, clonal, rhizomatous shrub and year to year population fluctuations are not expected to be high. Success of this monitoring plan will be reviewed and adjusted as needed and as management actions change.

Monitoring every 5 years will include the following parameters at known sites:

- Any beaver dams present and associated changes in the system;
- Invasive species introductions and spread;
- Forestry activity or signs of potential harvest;
- OHV use including new trails or evidence of damage in Hoary willow habitat;
- Road maintenance and work on associated infrastructure, and;
- Photo-monitoring at key sites to measure vegetation encroachment.

Monitoring every five years will include all of the above, plus complete population counts at all known sites.

In addition to the above, a subset of permanent sample plots may be established to measure succession and overall landscape changes over time. This may include measurements of willow vs. alder (% cover) and monitoring hydrology with waterloggers or sample wells.

A field checklist and more detailed methodologies for photo-monitoring, sample plots and population counts will be developed.

9. REFERENCES

Anderson, A.R. 1993. Peat moss in Nova Scotia. Information Circular 18, 2nd ed. Nova Scotia Department of Natural Resources, Mines and Energy Branches, Halifax, Nova Scotia. 17pp.

Anderson, A.R. and W.A. Broughm. 1988. Evaluation of Nova Scotia's peatland resources. Bulletin 6. Department of Mines and Energy, Halifax, Nova Scotia. 109 pp.

Argus, G. W. 1986. The genus Salix (Salicaceae) in the southeastern United States. Syst. Botany Monographs 9: 1-170.

Argus, G.W. 2006. Guide to Salix (willow) in the Canadian Maritime provinces (New Brunswick, Nova Scotia, and Prince Edward Island). Canadian Museum of Nature, Ottawa, ON. 49 pp.

Argus, G.W. 2010. *Salix candida*. In: Flora of North America Editorial Committee (eds.). 1993+. Flora of North America North of Mexico. 129 vols. Oxford University Press, New York and Oxford. Vol. 7, 141.

Beacon Environmental Ltd. 2012. Ecological buffer guideline review. Report prepared for Credit Valley Conservation. Web site: https://cvc.ca/wp-content/uploads/2013/08/Ecological-Buffer-Guideline-Review.pdf [Accessed August 2020].

Canadian Endangered Species Conservation Council. 2016. Wild Species 2015: The General Status of Species in Canada. National General Status Working Group. Web site: https://www.wildspecies.ca/reports [Accessed August 2020].

Churchill, J. and S. Blaney. 2018. Avifauna inventory of Nature Conservancy Canada's Black River fen properties, Inverness County, Nova Scotia. Report to Nature Conservancy of Canada. Atlantic Canada Conservation Data Centre, Sackville, NB. 11 pp.

Cremer, K.W. 2003. Introduced willows can become invasive pests in Australia. Biodiversity 4(4): 17-24.

Davis, D. and S. Browne (eds.). 1996. The Natural History of Nova Scotia Vol. 2, Theme Regions. Nova Scotia Museum and Nimbus Publishing. Halifax, NS. 304 pp.

Decker, K. 2006. *Salix candida* Flueggé ex Willd. (sageleaf willow): a technical conservation assessment. USDA Forest Service, Rocky Mountain Region. Web site: http://www.fs.fed.us/r2/projects/scp/assessments/salix candida.pdf [Accessed May 2019].

Environmental Law Institute. 2008. Planner's guide to wetland buffers for local governments, ELI Project No. 0627-01, 25 pp.

Faber-Langendoen, D., J. Rocchio, M. Schafale, C. Nordman, M. Pyne, J. Teague, T. Foti, and P. Comer. 2006. Ecological integrity assessment and performance measures for wetland mitigation. Final Report. NatureServe, Arlington, VA. 39 pp.

Gage, E.A. and D.J. Cooper. 2005. Patterns of willow seed dispersal, seed entrapment, and seedling establishment in a heavily browsed montane riparian ecosystem. Canadian Journal of Botany 83:678-687.

IUCN (International Union for Conservation of Nature). 2012. IUCN-CMP unified classification of direct threats (version 3.2). Web site: https://www.iucnredlist.org/resources/threat-classification-scheme [Accessed May 2019].

Kiviat, E. 2013. Risks to biodiversity from hydraulic fracturing for natural gas in the Marcellus and Utica shales. Annals of the New York Academy of Sciences 1286: 1-14. https://doi.org/10.1111/nyas.12146

Klymko, J., C.S. Blaney, and D.G. Anderson. 2012. The first record of Dorcas Copper (*Lycaena dorcas*) from Nova Scotia. Journal of the Acadian Entomological Society 8: 41-42.

Lesica, P. and F.W. Allendorf. 1995. When are peripheral populations valuable for conservation? Conservation Biology 9(4): 753-760.

Levine, R. and G. A. Meyer. 2019. Beaver-generated disturbance extends beyond active dam sites to enhance stream morphodynamics and riparian plant recruitment. Scientific Reports 9:8124. https://doi.org/10.1038/s41598-019-44381-2

NatureServe. 2019. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, VA. Web site: http://explorer.natureserve.org [Accessed May 2019].

Newell, R. E., 2010. Nova Scotia General Status Report on Hoary willow (*Salix candida*) Flűeggé *ex* Willd. Web site: https://novascotia.ca/natr/wildlife/conservationfund/final09/NSSARCF09_13_Salix_candida_status_report.pdf [Accessed August 2020].

Nova Scotia Department of Lands and Forestry. 2007. Nova Scotia Wetland Inventory (Updated 2018). Digital data. [Unpublished].

Nova Scotia Department of Lands and Forestry 2020. Nova Scotia Interpreted Forest Inventory. Digital data. Web site: https://nsgi.novascotia.ca/gdd/ [Accessed August 2020].

Nova Scotia Department of Lands and Forestry 2021. Nova Scotia Provincial Update Status Report for Hoary Willow (*Salix candida* Flueggé ex Willd.). Nova Scotia *Endangered Species Act Status Report Series.*

Taylor, A.R., D.A. MacLean, P.D. Neily, B. Stewart, E. Quigley, S.P. Basquill, C.K. Boone, D.Gilby, and M.Pulsifer. 2020. A review of natural disturbances to inform implementation of ecological forestry in Nova Scotia, Canada. Environmental Reviews 28(4): 387-414. https://doi.org/10.1139/er-2020-0015

The Council of Canadians, 2013. A fractivist's toolkit. Web site: https://canadians.org/fracktivists [Accessed August 2020].

USDA-NRCS (United States Department of Agriculture – Natural Resources Conservation Service). 2020. The PLANTS Database. National Plant Data Team, Greensboro, NC, USA. Web site: http://plants.usda.gov [Accessed August 2020].

Washington State Department of Natural Resources 2018. Rare plant field guide – *Salix candida.* Web site: https://www.dnr.wa.gov/publications/amp_nh_saca4.pdf [Accessed: August 2020].

Withers, P. 2018. Nova Scotia and New Brunswick face end of domestic supply of natural gas. CBC News. Web site: https://www.cbc.ca/news/canada/nova-scotia/nova-scotia-natural-gas-price-hikes-1.4566069 [Accessed March 2018].

Appendix 1: Maps of identified core habitat for Hoary willow in Nova Scotia

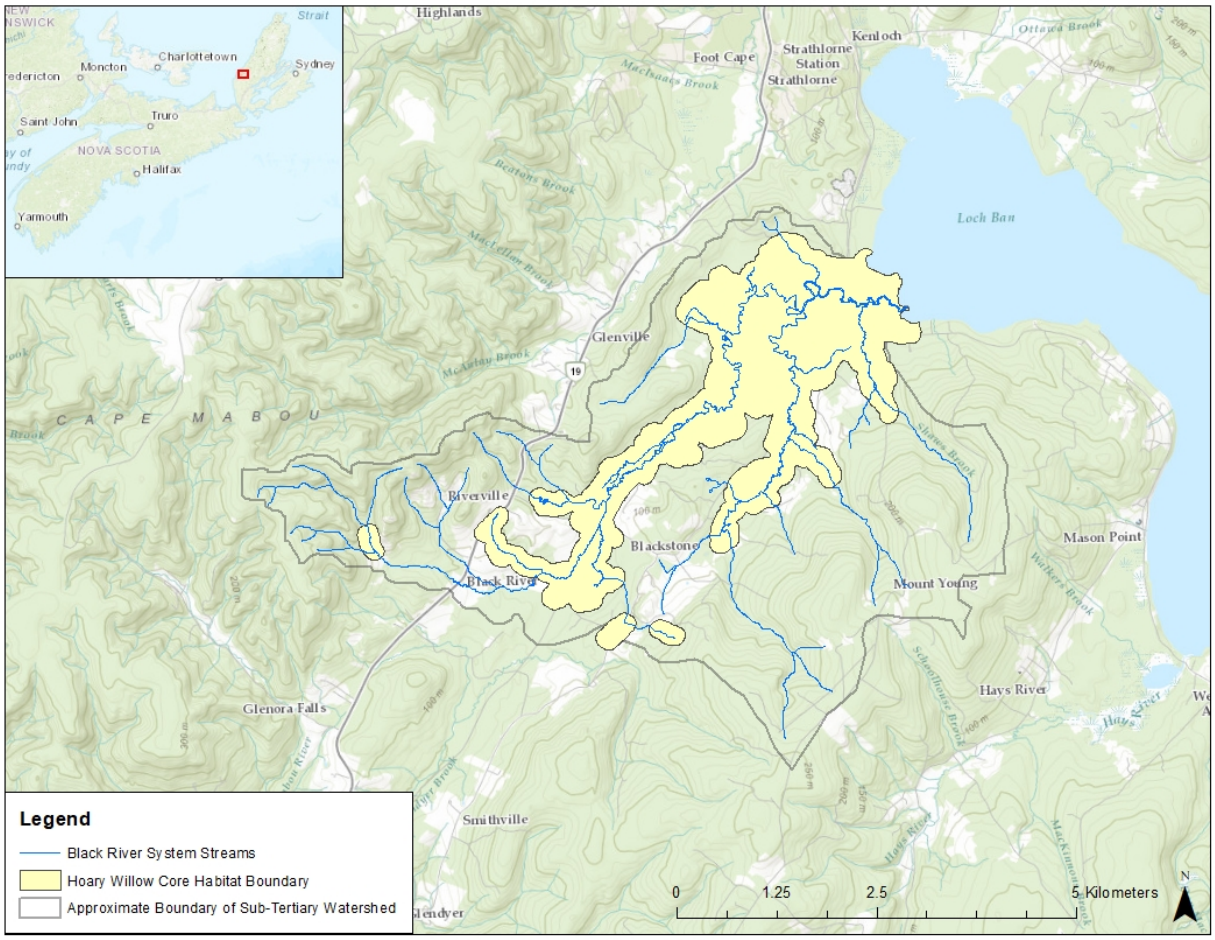

Figure 3. Identified core habitat for Hoary willow in Nova Scotia.

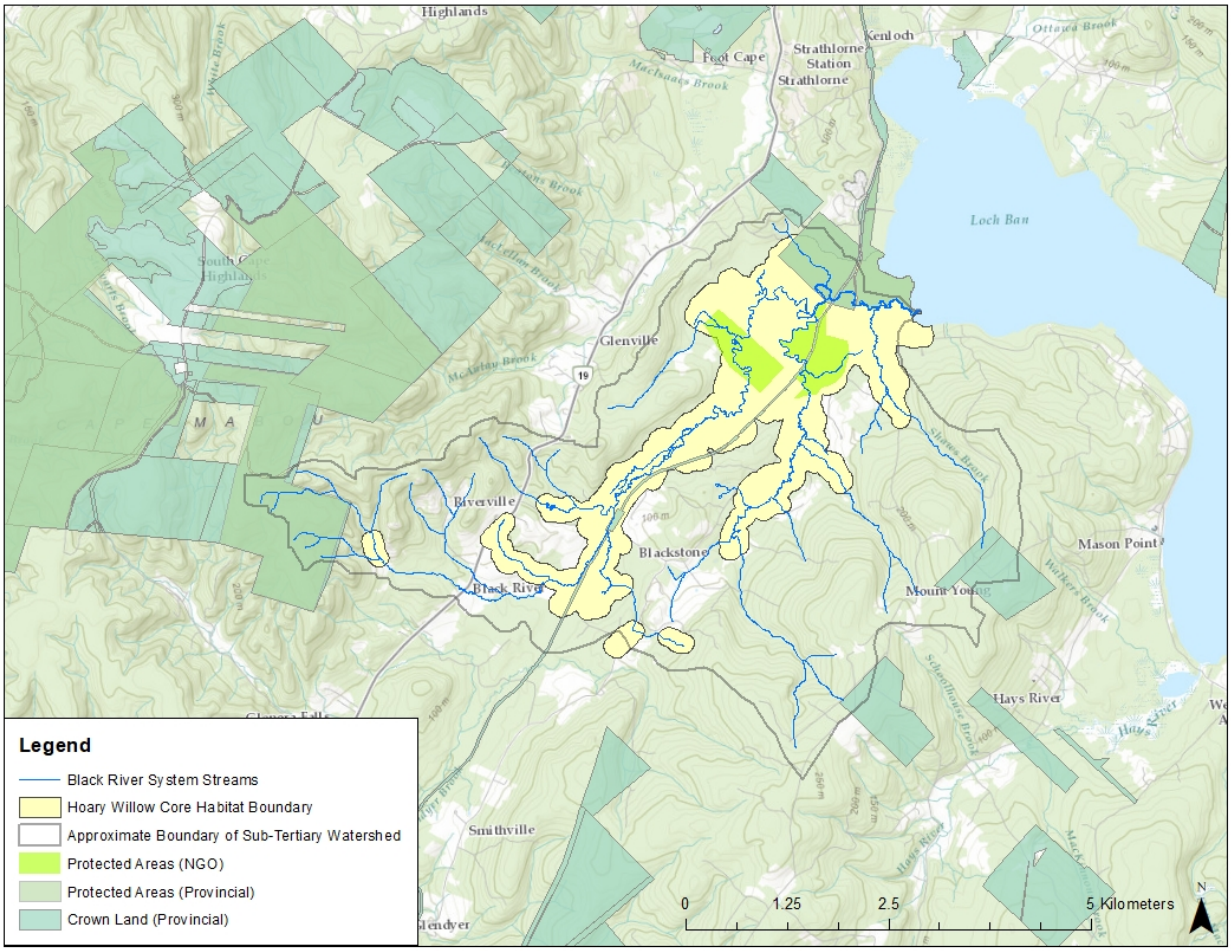

Figure 4. Land ownership in identified core habitat for Hoary willow in Nova Scotia.