Species Status Report

Hairy braya

Braya pilosa

Braya poilu (French)

IN THE NORTHWEST TERRITORIES

NORTHWEST TERRITORIES SPECIES AT RISK COMMITTEE

REASSESSMENT – THREATENED

April 2024

Species at Risk Committee status reports are working documents used in assigning the status of species suspected of being at risk in the Northwest Territories (NWT).

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ABOUT THE SPECIES AT RISK COMMITTEE

The Species at Risk Committee was established under the *Species at Risk (NWT) Act*. It is an independent committee of experts responsible for assessing the biological status of species at risk in the NWT. The Committee uses the assessments to make recommendations on the listing of species at risk. The Committee uses objective biological criteria in its assessments and does not consider socio-economic factors. Assessments are based on species status reports that include the best available Indigenous knowledge, community knowledge, and scientific knowledge of the species. The status report is approved by the Committee before a species is assessed.

ABOUT THIS REPORT

This species status report is a comprehensive report that compiles and analyzes the best available information on the biological status of hairy braya (*Braya pilosa*) in the NWT, as well as existing and potential threats and positive influences. Full guidelines for the preparation of species status reports, including a description of the review process, may be found at www.nwtspeciesatrisk.ca.

Environment and Climate Change, Government of the Northwest Territories, provides full administrative and financial support to the Species at Risk Committee.

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ASSESSMENT OF HAIRY BRAYA

The Northwest Territories Species at Risk Committee (SARC) met on April 24-26, 2024 and reassessed the biological status of hairy braya in the Northwest Territories. The assessment was based on this approved status report. The Species at Risk Committee determined that there was not enough available documented Indigenous and community knowledge (ICK) to prepare an ICK component of the status report. Therefore, the status report is based almost exclusively on scientific knowledge (SK). The assessment process and objective biological criteria used by the Species at Risk Committee are based on SK and are available at: www.nwtspeciesatrisk.ca.

Assessment: Threatened in the Northwest Territories

Threatened – The species is likely to become Endangered in the NWT if nothing is done to reverse the factors leading to its extirpation or extinction.

Reason for the assessment: Hairy braya fits criteria SK(B1) and (B2) and meet conditions (a) and (b) (i, ii, iii, iv, v) for Threatened.

Status Category	**Criterion**	
Threatened	SK(B1) The extent of occurrence is <20,000 km²	The extent of occurrence for hairy braya is approximately 457 km².
	SK(B2) The area of occupancy is <2,000 km²	The area of occupancy is approximately 96 km².
	(a) Number of locations ≤10	The number of locations is 10 with coastal erosion as the most plausible threat.
	(b) Continuing decline, observed, estimated, inferred, or projected, in any of: (i) extent of occurrence, (ii) area of occupancy, (iii) area, extent, or quality of habitat, (iv) number of locations or subpopulations, (v) number of mature individuals.	

Main factors:

- Increased range and numbers since the last assessment are due to an expanded search effort and research on its range.
- This species does not exist anywhere else in the world and is found in a very small area of the Northwest Territories that remained unglaciated during the last glacial period.

- Range is limited (extent of occurrence 457 km^2); index of area of occupancy 96 km^2.
- There are only 10 known locations, but there may be more on Cape Bathurst Peninsula.
- Coastal habitat continues to decline (~10 m/year erosion) and this is expected to increase due to climate change. Increasing sea level, storm surges, longer ice-free periods and melting permafrost all contribute to accelerating coastal erosion.
- Hairy braya only exists on Cape Bathurst Peninsula and Baillie Islands in the Northwest Territories, so there is no possibility of rescue from outside populations.
- Hairy braya has specialized habitat requirements and is unlikely to expand its range.
- The species does not compete well with other plant species when establishing or colonizing new areas.

Additional factors:

- Salinization is affecting coastal habitat, resulting in population decline.
- Increased drought conditions and lightning-caused wildfires are potential threats to the species.

Positive influences on hairy braya and their habitat:

- Hairy braya is found on the calving grounds of Cape Bathurst barren-ground caribou. For this reason, the Tuktoyaktuk Community Conservation Plan identifies the area as a conservation priority (category D – managed to eliminate, to the greatest extent possible, potential damage and disruption).
- As recommended in the 2012 assessment of hairy braya, field studies were conducted in 2022 to check areas of potential habitat on Cape Bathurst Peninsula and Baillie Islands to better describe the population and its distribution.
- The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed hairy braya in 2013 and the species was listed as Endangered under the federal *Species at Risk Act* in 2018.
- The extremely remote location means there is currently little human disturbance. The species is located on Inuvialuit Private Lands.

Assessment History:

- The NWT Species at Risk Committee met in December 2012 and assessed hairy braya as Threatened in the NWT because of its small range, shrinking habitat and declining population.

- In 2014, hairy braya was listed as Threatened in the NWT under the *Species at Risk (NWT) Act*.
- An NWT recovery strategy was completed in 2016 and a progress report was released in 2021.

Recommendations:

- Canada and the NWT must uphold and, if possible, exceed international climate change agreements including reducing greenhouse gas emissions at the local level. Climate change in the NWT must be addressed by implementing the 2030 NWT Climate Change Strategic Framework and Action Plan.
- Encourage continued research in Indigenous, community and scientific knowledge to understand hairy braya and changes to its habitat.
- Check areas of potential habitat on Cape Bathurst Peninsula and Baillie Islands to better describe the distribution and abundance of Hairy Braya.
- Encourage continued implementation of the Tuktoyaktuk Community Conservation Plan.
- Continue to monitor sea level change and rate of shoreline erosion on Cape Bathurst Peninsula and Baillie Islands.
- Continue to raise awareness of hairy braya and threats to its habitat to support recovery actions.

Executive Summary

About the Species
Hairy braya (*Braya pilosa*) is a perennial plant in the mustard family (Brassicaceae). The plants are 4.5 – 12.0 cm tall, arising from a tuft of basal leaves, with white flowers arranged in dense clusters. It is distinguished from other *Braya* species by its large flowers and ellipsoid to ovoid fruits with very long styles.
Place
Hairy braya is known to occur only in the Northwest Territories, Canada. There are approximately nineteen occurrences (17 extant and 2 extirpated) in four subpopulations located on the northern portion of Cape Bathurst peninsula and on nearby Baillie Islands, in the Inuvialuit Settlement Region. Hairy braya is restricted to an area that remained ice-free during the Pleistocene. Hairy braya occurs on bluffs and dry uplands composed of calcareous sandy loam and silty clay loam soils. It apparently requires bare soils for seedling establishment. Periods of standing water, erosion, and soil disturbance from grizzly bear digs and from caribou and muskox hooves appear to be involved in creating or maintaining these bare soil habitats. Although these habitats are quite extensive on the Cape Bathurst peninsula, they are often separated from each other by large areas of wet tundra, or by erosion or salinization. Coastal areas of Cape Bathurst Peninsula and Baillie Islands are rapidly eroding, and a decrease in arctic sea ice as well as other climate change-related factors are hastening the erosion of hairy braya habitat along the coast. Most known individuals of hairy braya are found inland or along protected coastal areas, in habitats that appear to be stable. Hairy braya is a long-lived (surviving for more than ten years) perennial plant that appears to be cross-pollinated. Its restricted distribution indicates a lack of ability to expand its distribution range. Hairy braya does not compete well with other plant species. Hybridization may occur rarely between hairy braya and smooth braya (*Braya glabella*), but this has not been substantiated.
Population
It is estimated that there are 25,000 to 50,000 plants in the 17 extant known occurrence sites (distributed among 4 subpopulations) of hairy braya. This population estimate is based general estimates made in the field. However, this is likely an underestimate. Population estimates based on density-area calculations from satellite imagery, which are likely an

overestimate, approach 1 million plants. Because hairy braya appears to mature in a single season, essentially all of these individuals are considered to be mature. Element occurrences on coastal bluffs are subject to rapid erosion and are clearly at risk of declining. Trends in element occurrences on protected sections of the coast and on inland bluffs have not been determined, but the habitats themselves appear to be stable. Little is known about the population structure and demographics of the species.

Threats and Limiting Factors

Some coastal clusters of hairy braya are threatened by the rapid erosion of coastline habitat at a rate of about 2 to about 10.9 m per year. Sea level is predicted to increase by 0.2 to 1.0 m over 100 years while land and sea ice are expected to decrease, leading to increased erosion due to coastal permafrost thawing, increased wave height, and an increased probability of storm surges. Continued warming also has the potential to increase the risk of tundra fires in the Arctic via increased lightning combined with drought conditions. Stochastic events such as storm surges could impact coastal hairy braya occurrences. Salinization (habitat destruction due to salt from ocean spray and waves) also acts on some coastal habitats so this threat acts in advance of coastal erosion, but at an unknown rate.

Positive Influences

Due to the remoteness of Cape Bathurst Peninsula and Baillie Islands, hairy braya faces little direct threat from human activities. The area is also managed carefully by the Inuvialuit. Under the Inuvialuit Final Agreement (IFA), the entire range of hairy braya is Inuvialuit private land managed by the Inuvialuit Land Administration (ILA). Development of any kind would require ILA approval, normally subject to consultation with the Tuktoyaktuk Hunters and Trappers Committee. Additionally, the IFA established a process for environmental screening and review of development projects, and requires that mining, oil and gas or quarrying may not take place on Cape Bathurst peninsula or Baillie Islands without approval from Government of Canada.

The Cape Bathurst peninsula includes the calving ground of the Cape Bathurst caribou population. For this reason, the Tuktoyaktuk Community Conservation Plan recommends that the area be managed to eliminate, to the greatest extent possible, potential damage and disruption. Portions of the hairy braya range have also been identified as critical habitat for hairy braya under the federal *Species at Risk Act*, which requires that critical habitat be protected from destruction. Hairy braya range has also been designated as a Key Biodiversity Area.

In the past decade, hairy braya has been legally listed as a species at risk in the NWT and in Canada. A recovery strategy was completed and implementation is ongoing. In addition to monitoring, seeds from across the range of hairy braya have been deposited in the Millennium Seed Bank at the Royal Botanic Gardens, Kew to conserve them for the future, and communications and awareness about hairy braya have increased.

Technical Summary

Question	Scientific Knowledge
Population Trends	
Generation time (average age of parents in the population) (indicate years, months, days, etc.).	The species appears to be a long-lived (of at least 10-15 years) perennial that matures in a single season. Therefore, the average age of the population is equal to the generation time. If hairy braya plants live for 10-15 year, a generation time would be approximately 5-7 years.
Number of mature individuals in the NWT (or give a range of estimates).	A rough estimate made in the field in 2022 is between 25,000 and 50,000 individuals, with essentially all of these being mature. However, these estimates are likely too low. Estimates based on area-density calculations and potential habitat identified from satellite imagery indicate a total population of 983,000 plants, an estimate that is likely too high. The actual number of hairy braya individuals is almost certainly intermediate to both of these estimates.
Percent change in total number of mature individuals over the **last** 10 years or 3 generations, whichever is longer.	The change in numbers cannot be quantified, but the loss of some coastal hairy braya sites due to erosion and sea spray has undoubtedly reduced the total number.
Percent change in total number of mature individuals over the **next** 10 years or 3 generations, whichever is longer.	Based on a generation time estimate of 5-7 years, 3 generations would be 15-21 years. At the upper estimate of coastal erosion (10 metres per year), about 150-210 metres of hairy braya habitat along the coast would be lost over the next 3 generations. This amount of erosion would likely impact 5 of the 17 extant EOs. Two EOs (l & i) would be lost entirely, and 3 (q, g, and o) would be greatly reduced. However, because the overwhelming majority of hairy braya individuals are not found along the

	coast, the percent reduction in the total number of individuals would be less than 1%.
Percent change in total number of mature individuals over any 10 year or 3 generation period that includes **both the past and the future**.	Of the 19 total known occurrences of the species, two were lost between 2011 and 2022 and two more are expected to be lost completely over the next 3 generations. However, even a total loss of at-risk coastal occurrences over any 3-generation period would represent less than a 1% change in the total number of individuals.
If there is a decline in the number of mature individuals, is the decline likely to continue if nothing is done?	The loss of coastal habitat is occurring rapidly (2.0 to 10.9 m per year), so hairy braya individuals in coastal sites will certainly continue to decline. But when the sites at risk of loss by erosion are gone the number of mature individuals may stabilize.
If there is a decline, are the causes of the decline reversible?	The loss of habitat due to erosion, accelerated by changing climate patterns, is not reversible, at least not within a timeframe that would prevent the expected loss of some coastal habitat.
If there is a decline, are the causes of decline clearly understood?	Habitat loss due to coastal erosion is clearly understood.
If there is a decline, have the causes of the decline been removed?	The causes of the decline cannot be removed.
If there are fluctuations or declines, are they within, or outside of, natural cycles?	Declines in the number of hairy braya individuals are primarily the result of human-caused climate change.
Are there 'extreme fluctuations' (>1 order of magnitude) in the number of mature individuals?	No. Because the majority of hairy braya plants are growing at inland sites, even a complete loss of all coastal occurrences would not constitute an order of magnitude change.
Distribution	

Estimated extent of occurrence in the NWT (in km²).	The estimated extent of occurrence is approximately 457 km².
Index of area of occupancy (IAO) in the NWT (in km²; based on 2 x 2 grid).	A minimum estimate of the index of area of occupancy is approximately 96 km².
Number of extant locations[1] in the NWT.	There are 10 identified locations.
Is there a **continuing decline** in area, extent, and/or quality of habitat?	The decline in habitat due to rapid rates of coastal erosion and increased sea spray over recent decades will likely continue until at-risk element occurrences are gone.
Is there a **continuing decline** in number of locations, number of populations, extent of occupancy, and/or IAO?	The decline in number of element occurrences, locations and IAO due to rapid rates of coastal erosion over recent decades will likely continue until at-risk locations are gone. This will reduce the extent of occurrence of the species.
Are there 'extreme fluctuations' (>1 order of magnitude) in number of locations, extent of occupancy, and/or IAO?	No
Is the total population 'severely fragmented' (most individuals found within small and isolated populations)?	No
Immigration from Populations Elsewhere	
Does the species exist elsewhere?	No

[1] Extant location - The term 'location' defines a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the species present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations. Where a species is affected by more than one threatening event, location should be defined by considering the most serious plausible threat.

Status of the outside population(s)?	N/A
Is immigration known or possible?	No
Would immigrants be adapted to survive and reproduce in the NWT?	N/A
Is there enough good habitat for immigrants in the NWT?	N/A
Is the NWT population self-sustaining or does it depend on immigration for long-term survival?	The population is self-sustaining.
Threats and Limiting Factors	
Briefly summarize negative influences and indicate the magnitude and imminence for each.	Some coastal element occurrences of hairy braya are threatened by salinization and the rapid erosion of coastline habitat at a rate of 2.0 to 10.9 m per year. Sea level is predicted to increase by 0.2 to 1.0 m over 100 years, leading to increased erosion and an increased probability of storm surges. Continued warming and drought conditions may also increase the risk of lightning-caused tundra fires. Stochastic events such as storm surges could impact hairy braya, but they are not likely to have a significant impact on the largest portions of the population, which are inland.
Positive Influences	
Briefly summarize positive influences and indicate the magnitude and imminence for each.	Due to the remoteness of Cape Bathurst peninsula, hairy braya faces little direct threat from human activities. The Cape Bathurst peninsula includes the calving ground of the Cape Bathurst caribou population, and the Tuktoyaktuk Community Conservation Plan recommends that the area be managed so as to eliminate, to the greatest extent possible, potential damage and disruption.

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Preface

In the preparation of this report, an effort was made to find sources of Indigenous knowledge, community knowledge, and scientific knowledge. Unfortunately, there is little available documented Indigenous or community knowledge for hairy braya. Therefore, this report is based almost exclusively on scientific knowledge.

ABOUT THE SPECIES

Names and Classification

Scientific Name:	*Braya pilosa* (Hooker, Flora Boreali-Americana 1830)
Common Name (English):	hairy braya; pilose braya (Harris 2004)
Synonyms:	*Braya purpurascens* [(R. Brown) Bunge ex Ledebour, Flor. Ross. (1841) forma p*ilosa* (Hooker) Schulz, Pflanzenreich 86 (1924) *Braya purpurascens* (R. Brown) Bunge ex Ledebour, Flor. Ross. (1841) subsp. *pilosa* (Hooker) Hultén, Circumpolar plants II (1970)]
Common Name (French):	braya poilu
Subpopulations:	17 extant element occurrences in 4 subpopulations: Baillie Islands, Northern Cape Bathurst, Northwest Coast, and Southern Interior
Order:	Brassicales
Family:	Brassicaceae (Cruciferae) (mustard family)
Life Form:	Herbaceous perennial plant

Systematic/Taxonomic Clarifications

Hairy braya (*Braya pilosa*) was named and described by Hooker (1830) from collections made by Sir John Richardson southwest of Cape Bathurst in 1826 (Richardson 1828; Harris 2004). Although *Braya* collections from elsewhere in the Northwest Territories, Yukon, Northern Alaska, and Russia have occasionally been labeled as hairy braya, only those from Cape Bathurst Peninsula and Baillie Islands have been authenticated as the species Hooker described (Harris 2004 and 2010).

Description

Hairy braya is a long-lived (more than ten years) perennial plant with one to 30 stems from a branched root crown. Each of these stems produces a dense radiating cluster (a rosette) of leaves at ground level, and in a given year each stem may or may not also produce a flowering stalk (a scape) (Figures 1, 2 and 3).

The leaves are 0.7-2.0 cm in length by 0.7-2.5 mm in width and moderately to densely hairy Figures 2 and 3). The flowering/fruiting stalks are 1.0-12.0 cm long and erect (upright) to ascending (inclined upward) to almost prostrate (lying flat). The stalks are leafless, or rarely with a single small leaf just below the lowermost flower or fruit, and densely hairy with straight and tangled hairs. The flowers are borne in dense clusters of five to many and have four white petals 3.7-6.6 mm long by 2.0-5.0 mm wide (Figure 1). The fruits are ovoid (egg-shaped) to ellipsoid,

5.0-6.0 mm long by 3.0-4.0 mm wide, and pubescent (covered with short simple and 2-forked hairs; Figure 2, 4 and 5). The narrow style at the top of the fruit is 1.0-2.0 mm long and capped with a usually broadly expanded stigma (Figure 4). The light-brown, oblong seeds are 0.7-0.9 mm long by 0.4-0.6 mm wide (Figure 5; Harris 1985, 2004, 2010; Harris *et al.* unpubl. data 2011).

The flowering stalks and fruits of hairy braya are usually yellow-green in colour until late in the breeding season (Figure 2), allowing the plants to be quickly and easily distinguished from the darker green flowering stalks and fruits of smooth braya (*Braya glabella*), which co-occurs with hairy braya in some areas.

Hairy braya is distinguished from Greenland braya (*Braya thorild-wulffii*) by the much larger flowers, longer styles, and more upright flowering stalks. The known distribution ranges of hairy braya and Greenland braya do not overlap.

Figure 1. Hairy braya from the type locality. Photo credit: J. Harris.

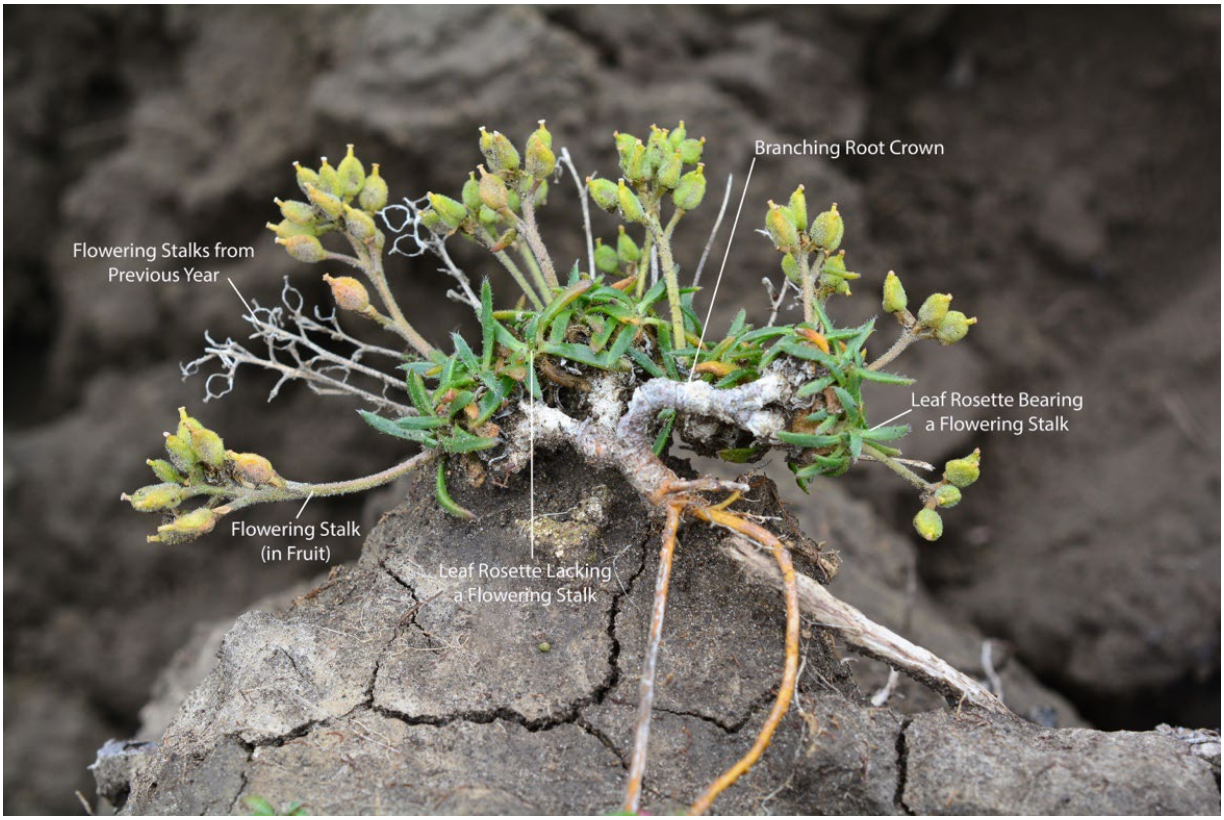

Figure 2. The soil has eroded from the roots of this hairy braya plant, revealing the branched root crown that gives rise to multiple stems. Some stems have produced both leaves and a flowering stalk (the stalks are in fruit in this photo), while others have produced leaves only. Photo credit: Paul Sokoloff, Canadian Museum of Nature.

Figure 3. Hairy braya leaf rosettes on stems that did not produce flowering stalks this growing season. Leaf rosettes typically range from 1 -3 cm in diameter. Photo credit: Paul Sokoloff, Canadian Museum of Nature.

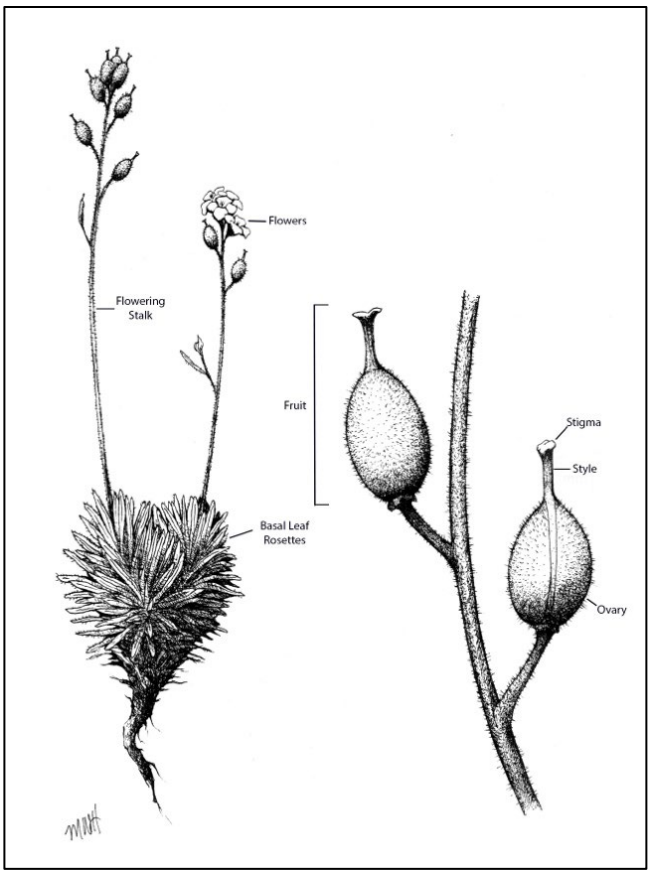

Figure 4. Illustration of hairy braya, by Melinda Woolf Harris.

Figure 5. Hairy braya opened fruits and seeds. Photo credit: Paul Sokoloff, Canadian Museum of Nature.

Life Cycle and Reproduction

The life cycle and reproduction of hairy braya have not been adequately studied. This is due in part to the difficulty in coaxing cultivated hairy braya plants to flower, a trait the species shares with Greenland braya, its closest relative. The seeds of all North American species of *Braya* (including those of hairy braya) germinate readily without any required pre-treatment, and within a matter of weeks individuals of most *Braya* species flower, fruit, and set seed (Harris 1985). Hairy braya and Greenland braya, however, remain indefinitely in a vegetative state in cultivation (Harris unpubl. data 2019). This may indicate a greater sensitivity to environmental conditions, conditions that have not been met adequately in cultivation.

Although most *Braya* species are self-pollinating (Harris 1985), hairy braya is likely cross-pollinating (Harris 1985, 2004). Visits to hairy braya flowers by pollinators have not been observed in the field, but the plant has several characteristics common to out-crossing species generally (species where pollination takes place between flowers on two separate plants) (Ornduff 1969; Grundt *et al*. 2005), and to out-crossing *Braya* species specifically (Harris 1985,

2004). These include: large fragrant flowers (Richardson 1828; Hooker 1830; Harris *et al.* unpubl. data 2011), exceptionally long styles, rotate corollas, a relatively high frequency of abortive silicles, a low ploidy level (low number of chromosome sets in a cell) (Harris unpubl. data 2011), a comparatively dense population structure (see Population Dynamics), and a narrow distribution limited to unglaciated lands.

Although Arctic pollination has not been adequately studied, the open, shallow flowers of hairy braya are accessible to a range of generalist pollinators common in the Arctic, including Muscid flies (Tiusanen, et al. 2016), bees, and butterflies (Burns, et al. 2022).

The thick taproots, many-branched root crowns, and thick thatch of old leaves and leaf bases indicate that hairy braya is a fairly long-lived perennial (life span of perhaps 10-15 years) with a generation time (average age of parents in the population) of perhaps 5-7 years.

Physiology and Adaptability

No work has been done to establish the physiology and adaptability of hairy braya. Nonetheless, some reasonable assumptions about the species can be made. First, the extremely limited distribution of hairy braya strongly suggests that the species has little ability to expand its distribution range and move onto seemingly appropriate habitat in surrounding areas. Since the seeds of hairy braya are neither more nor less adapted for dispersal than those of other *Braya* species that are more widely distributed, the narrow distribution of hairy braya is probably due to the fact that out-crossing plants, as hairy braya is presumed to be, are not able to generate new subpopulations from the establishment of a single individual in a new area. The rare dispersal of a seed from a self-pollinating species may produce a new subpopulation, but two rare seed dispersal events are required to establish a new subpopulation of an out-crossing species. In addition, hairy braya may require stable habitats over long periods of time (i.e., longer than the 15,000 years that have elapsed since the last glacial maximum) in order to establish and maintain viable subpopulations. The plant's distribution pattern mirrors that of some subspecies of *B. humilis* (subsp. *maccallae* and subsp. *porsildii*), which are also out-crossing, of low ploidy level, and limited to small areas in the Rocky Mountains on or near unglaciated lands (Harris 1985, 2010).

Interactions

Species in the genus *Braya* typically do not compete well with other plant species and require bare soils (e.g., gravel bars, riverbanks, lake and seashores, moraines, solifluction soils) for seedling survival (Harris 1985, 2010). It appears that most subpopulations of hairy braya use soils that are bare due to physical processes, such as erosion or periods of standing water (Harris *et al.* unpubl. data 2011; Wilson *et al.* in prep.). However, some hairy braya subpopulations are dependent on soil disturbance by caribou and muskox hooves or grizzly bear digs to provide or maintain bare soils where seedlings can become established (Harris 2004; Wilson *et al.* in prep.).

Hairy braya plants with cropped flowering stalks and leaves, apparently from grazing, are occasionally seen (Wilson *et al.* in prep.), but it is unknown if caribou, muskox, rodents, or birds (large flocks of geese, for example, feed in the area during the summer) are eating the plants. In any case, it does not appear that grazing has a significant impact on hairy braya populations.

The widespread smooth braya, which is sometimes found growing in close proximity to hairy braya (Harris *et al.* unpubl. data 2011; Wilson *et al.* in prep.), is an allopolyploid (a hybrid containing extra sets of chromosomes) that likely arose from hybridization between two *Braya* species of lower ploidy level (Warwick *et al.* 2004). The out-crossing hairy braya has been considered a likely candidate for one of the parent species (Harris 1985, 2004). There is some indication from DNA sequence data (Harris unpubl. data 2011) that some crossbreeding is still occurring between hairy braya and nearby smooth braya plants. Crossbreeding, however, must be quite limited. A genome-wide study (Harris unpubl. data 2019) of approximately 20,000 genetic markers unambiguously distinguished the two species.

It has long been known, based on morphology (Harris 1985) and DNA sequence data (Harris unpubl. data 2011), that hairy braya is most closely related to Greenland braya, a species that is distributed primarily in Greenland and the more northerly islands of the Canadian Arctic Archipelago. The most southerly known subpopulations are found on the southern portions of Banks Island (Harris 2010). Greenland braya has not been reported from continental North America. Fieldwork conducted on Cape Bathurst Peninsula in 2011 (Harris 2011) and 2022 (Wilson 2022) indicates that the relationship between hairy braya and Greenland braya needs to be more closely evaluated. The large number of hairy braya individuals observed in the field in 2011 and 2022 showed a much wider range of morphological variation than previously documented in the species. Plants ranged from large-flowered, erect individuals closely matching previous published descriptions of hairy braya (Hooker 1830; Harris 1985, 2004, 2010) to somewhat smaller-flowered, decumbent (spreading horizontally) individuals similar in appearance in some respects to Greenland braya. The morphological distinctiveness of these closely related species breaks down somewhat in some hairy braya individuals although they remain consistently distinguishable.

It had been assumed (Harris 1985) that a diploid (two sets of chromosomes per cell) hairy braya gave rise to the tetraploid (four sets of chromosomes) Greenland braya, and that this new polyploid species was then able to move north into high-arctic regions beyond the coast of continental North America. However, the ploidy level of several hairy braya individuals from the type locality were analyzed with flow cytometry (Harris unpubl. data 2012) and found to be tetraploid rather than diploid as anticipated. This casts some doubt on the notion that Greenland braya is a polyploid offspring of a diploid hairy braya. It should be noted, however, that ploidy has been determined only in a single subpopulation of hairy braya, so it is possible that diploid individuals may indeed occur on Cape Bathurst Peninsula. The highly variable plants discovered

on Cape Bathurst Peninsula in 2011 and 2022, with a significant number of individuals bearing a resemblance in some attributes to the tetraploid Greenland braya, could be due at least in part to differences in ploidy level among individuals in known subpopulations of hairy braya. A genome-wide sampling (Harris unpubl. data 2019) of approximately 20,000 genetic markers confirmed the very close relationship between Greenland braya and hairy braya.

A thorough genetic analysis of hairy braya, smooth braya, and Greenland braya is required before the relationships between these species can be definitively determined.

PLACE

Distribution

Hairy braya is restricted to the Northwest Territories of Canada (Hooker 1830; Harris 1985, 2004, 2010) (Figures 6). Hairy braya occurs on the northwestern portion of Cape Bathurst Peninsula and on nearby Baillie Islands (Table 1 and Figure 7), an area that escaped Pleistocene glaciation (Prest 1969, Dyke *et al.* 2003). The Cape Bathurst peninsula and Baillie Islands, which encompass the entire known range of hairy braya, is Inuvialuit private land under the Inuvialuit Final Agreement (DIAND 1984).

Element occurrences (i.e., groups of hairy braya plants) were delimited following NatureServe (2020) protocols for habitat-based plant element occurrences. An element occurrence is a group of hairy braya occurrences that are separated by less than 1 km, or if separated by 1 to 3 km, with no break in suitable habitat between them exceeding 1 km. There are 19 known element occurrences of hairy braya (17 extant and 2 extirpated). The 13 groups of hairy braya described as "subpopulations" or "populations" in previous status reports (SARC 2012; COSEWIC 2013) are comparable to the 19 element occurrences in this report.

In this report, subpopulations are defined as geographically distinct groups between which there is likely little demographic or genetic exchange, according to IUCN guidance (IUCN Standards and Petitions Committee 2022). There are four subpopulations of hairy braya: Baillie Islands, Northern Cape Bathurst, Northwest Coast, and Southern Interior (Figure 6).

On the basis of current knowledge, the total extent of occurrence is approximately 457 km^2 (Figure 8), and the index of area of occurrence (IAO) based on 2 km x 2 km grid squares is 96 km^2 (Figure 9). It should be noted, however, that the occurrences of hairy braya in the southerly portions of its range were discovered in 2022 through spot checks at helicopter landing sites within a rather large area of potential habitat. It is almost certain that many if not most of these occurrences are actually interconnected. If that is the case, IAO would increase significantly.

Locations

A location is defined as "a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. The size of the location depends on the area covered by the threatening event and may include part of one or many element occurrences. Where a taxon is affected by more than one threatening event, location should be defined by considering the most serious plausible threat" (IUCN 2022; Species at Risk Committee 2010). For hairy braya, the most serious threat is loss of habitat along coastal shorelines due to erosion (see the section on Threats and limiting factors). The most plausible threats for inland habitats are less clear but may include local stochastic events due to changes in water availability (e.g., drought, flooding) or natural disturbances (see Threats and limiting factors). Salinization also acts on some coastal habitats so this threat will act in advance of coastal erosion, but at an unknown rate. This threat was included as part of the coastal erosion threat in determining locations for hairy braya.

Based on estimated rates of coastal erosion, all element occurrences within one km of exposed coastal shorelines face possible extirpation within about 100 years, so all element occurrences in that zone were considered Location 1 (element occurrences g, i, l, m, o, q, r; Table 1 and Figure 7). Element occurrences within 2 km of these shorelines face extirpation within about 200 years and were grouped as Location 2 (element occurrences n and s); one element occurrence (p) within 3 km of these shorelines faces extirpation within about 300 years and constitutes Location 3. The likelihood and timing of potential stochastic threats to element occurrences farther than 3 km from the coast are impossible to predict, but it is clear that these threats are far less serious than the erosional threats along coastlines. No one stochastic event can eliminate the remaining element occurrences, therefore they are considered separate locations (element occurrences a, b, c, d, e, f, h). The rates of coastal erosion were estimated based on current sea level in the Beaufort Sea and on current frequencies of storms; these rates are expected to increase with melting permafrost, rising sea levels and changes in storm events with climate change (see the section on Habitat trends).

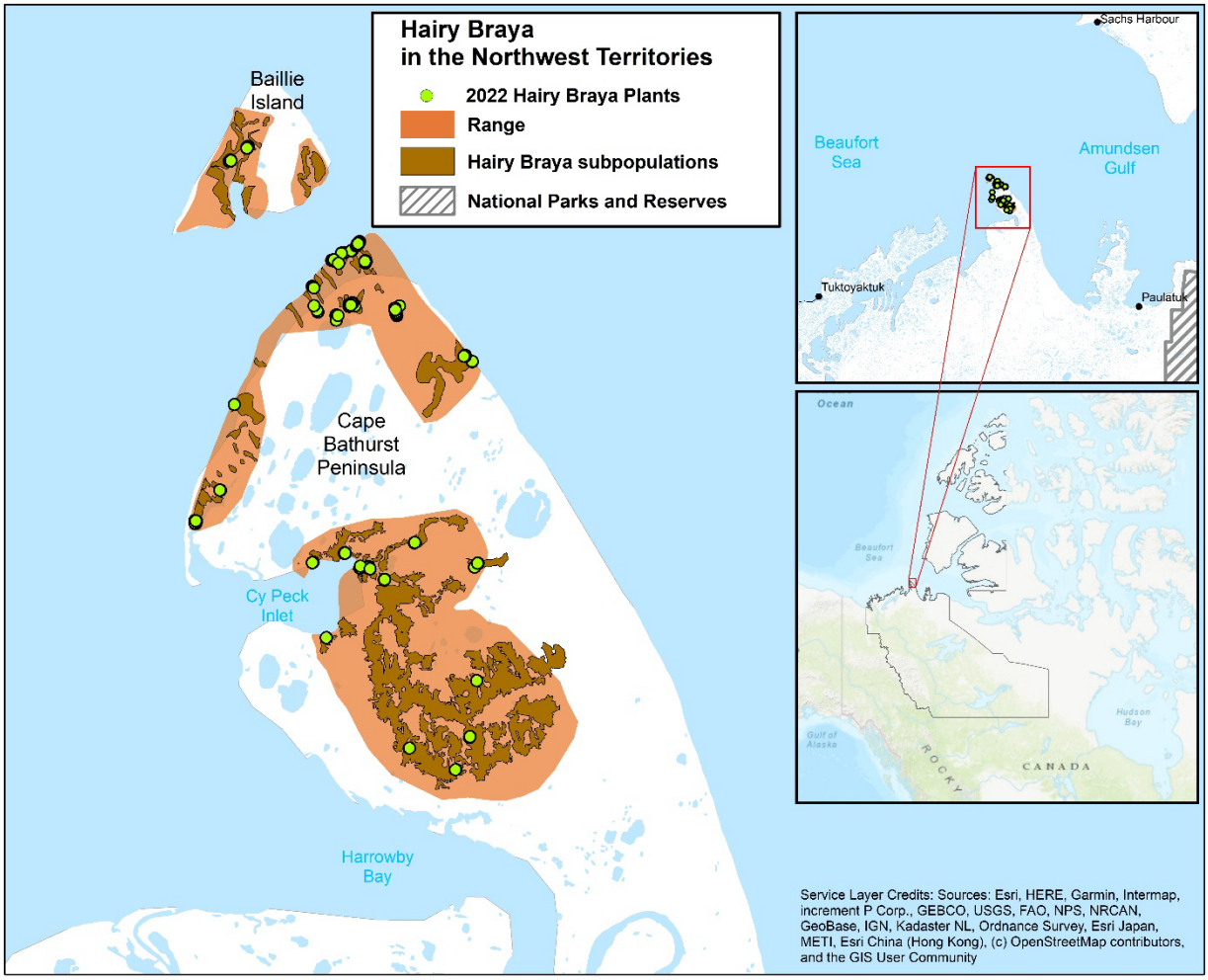

Figure 6. Hairy braya range, subpopulations and plants (2022) on Cape Bathurst and Baillie Islands, NWT. Data from Wilson *et al.* in prep. Map courtesy of N. Wilson, ECC.

Table 1. Known element occurrences (EOs) of hairy braya. Approximate sizes of EOs were estimated in summer 2022 (Wilson *et al.* in prep.).

Element Occurrences	Estimated Number of Individuals	Location[1]	Estimated Density (plants / 100 m²)
a	*	4	1.5
b	*	5	0.3
c	*	6	0.6
d	*	7	1.3
e	>10,000	8	0.8
f	hundreds	9	2.9
g	hundreds	1	1.0
h	hundreds	10	1.2
i	20	1	0.1
j	extirpated	Formerly 1	0.0
k	extirpated	Formerly 1	0.0
l	100	1	0.4
m	*	1	0.7
n	many hundreds	2	1.3
o	*	1	0.9
p	many hundreds	3	1.2
q	many hundreds	1	1.0
r	50	1	0.5
s	300	2	4.6

[1]Locations are based on the timeline of potential disappearance due to coastal erosion and various stochastic events. Based on estimated rates of coastal erosion, all EOs within 1 km of rapidly eroding northwest-facing shorelines face potential extirpation within about 100 years, so all EOs in that zone were considered one location (Location 1). EOs within 2 km of these shorelines face potential extirpation within about 200 years and were grouped as Location 2; EOs within 3 km of these shorelines face potential extirpation within about 300 years and were grouped as Location 3; and EOs more than 3 km from the coast and not subject to foreseeable coastal erosion constitute Locations 4 to 10. It should be noted that the distance between the coast and an EO was measured to the closest hairy braya plant. Therefore, some portions of EOs are farther inland than the distance indicated and would be expected to survive beyond the estimated extirpation time for the EO.

* Asterisk indicates that it was not possible to estimate the number of individuals (plants dispersed over large area).

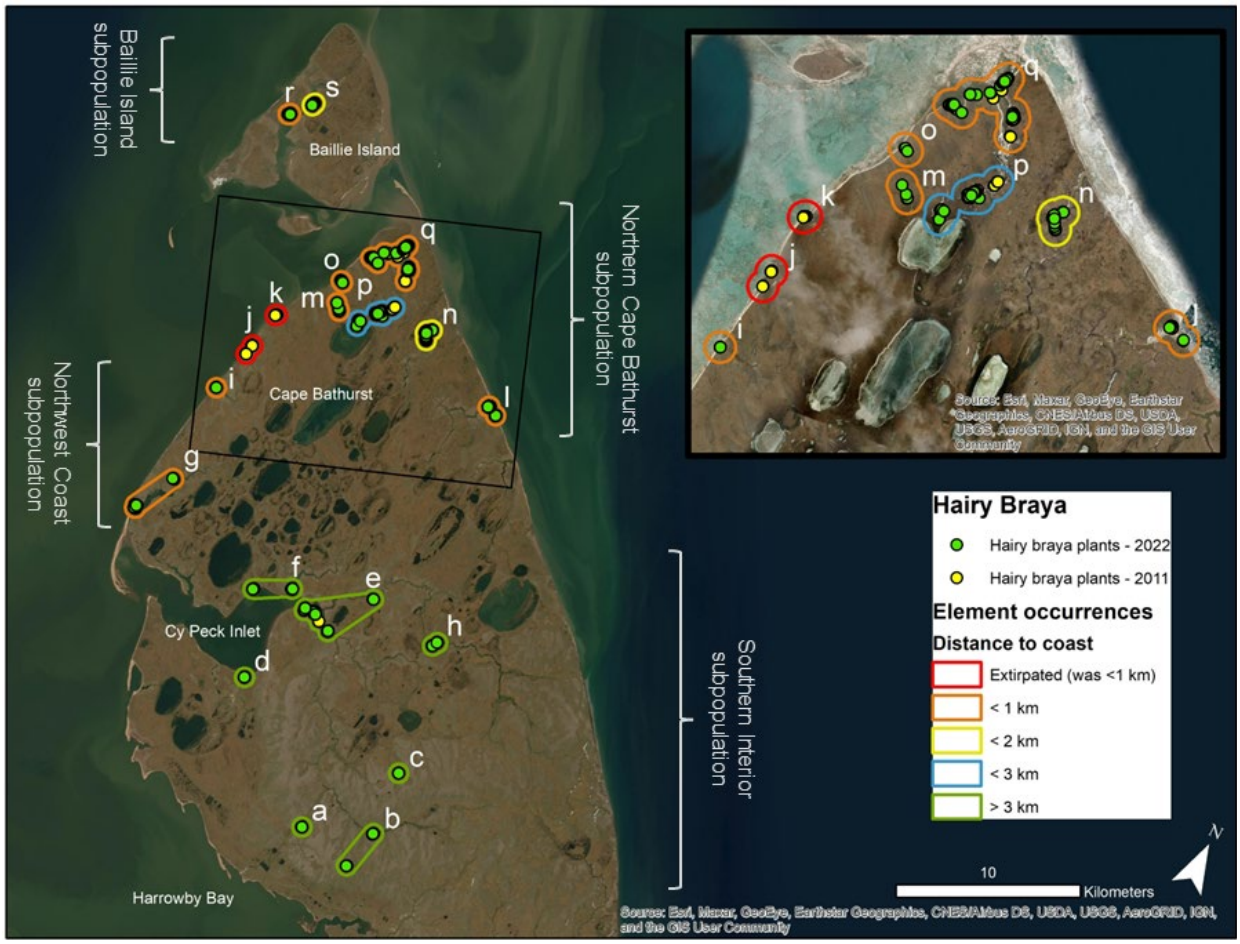

Figure 7. Subpopulations, element occurrences (EOs) and hairy braya plants on Cape Bathurst peninsula and Baillie Islands, NWT observed during the 2011 and 2022 surveys. Subpopulations include Baillie Islands, Northern Cape Bathurst, Northwest Coast, and Southern Interior. EOs are colour-coded to indicate risk of erosion as follows: Red: Extirpated (formerly Location 1); Orange: Location 1 (most at risk); Yellow: Location 2; Blue: Location 3; Green: Locations 4-10 (least at risk) (Wilson *et al.* in prep.). Map Courtesy of J. Wilson, ECC.

Figure 8. Extent of occurrence of hairy braya is calculated as the area included in a polygon without concave angles that encompasses the geographic distribution of all known subpopulations (Species at Risk Committee 2010). The green dots represent hairy braya plants. The map shows all known extant occurrences of hairy braya (Wilson *et al.* in prep.). Map Courtesy of M. Routh and N. Wilson, ECC.

Figure 9. Index of Area of Occurrence (IAO) of hairy braya. The IAO is a measure that aims to provide an estimate of area of occupancy that is not dependent on scale and that can be compared across taxonomic groups. The IAO is measured as the surface area of 2 x 2 km grid cells that intersect the actual area occupied by the species (i.e., the biological area of occupancy; Species at Risk Committee 2010). The green dots represent hairy braya plants. The map shows all known extant occurrences of hairy braya (Wilson *et al.* in prep.). Map Courtesy of M. Routh and N. Wilson, ECC.

Search Effort

Hairy braya was first collected in 1826, followed by subsequent collections in 1848 and 1850. All of these collections apparently came from the same site (Harris 2004). From 1850 until 2004, when the type locality of the plant was rediscovered southwest of Cape Bathurst at the site of element occurrence k, the species was lost to science (Harris 2004). Fieldwork conducted on Cape Bathurst peninsula in late July and early August of 2011 (Harris 2011) confirmed the persistence of the plant at the original site and led to the discovery of several additional occurrence sites. Over a four-day period approximately 60 linear kilometres in the northern portion of the peninsula were traversed on foot by J. Harris, B. Bennett, and F. Ruben. Information gathered on foot about the habitat preferences of the plant was then used for a one-day survey of surrounding areas by helicopter (Figure 10). Although several sites on the eastern coast of the peninsula as far south as the Horton River delta were surveyed, hairy braya was not seen on this side of the peninsula. The available helicopter flight time was not sufficient to determine the southern limits of the plant on the western side of the peninsula; search effort on the western side was limited to north of 70.358 degrees north.

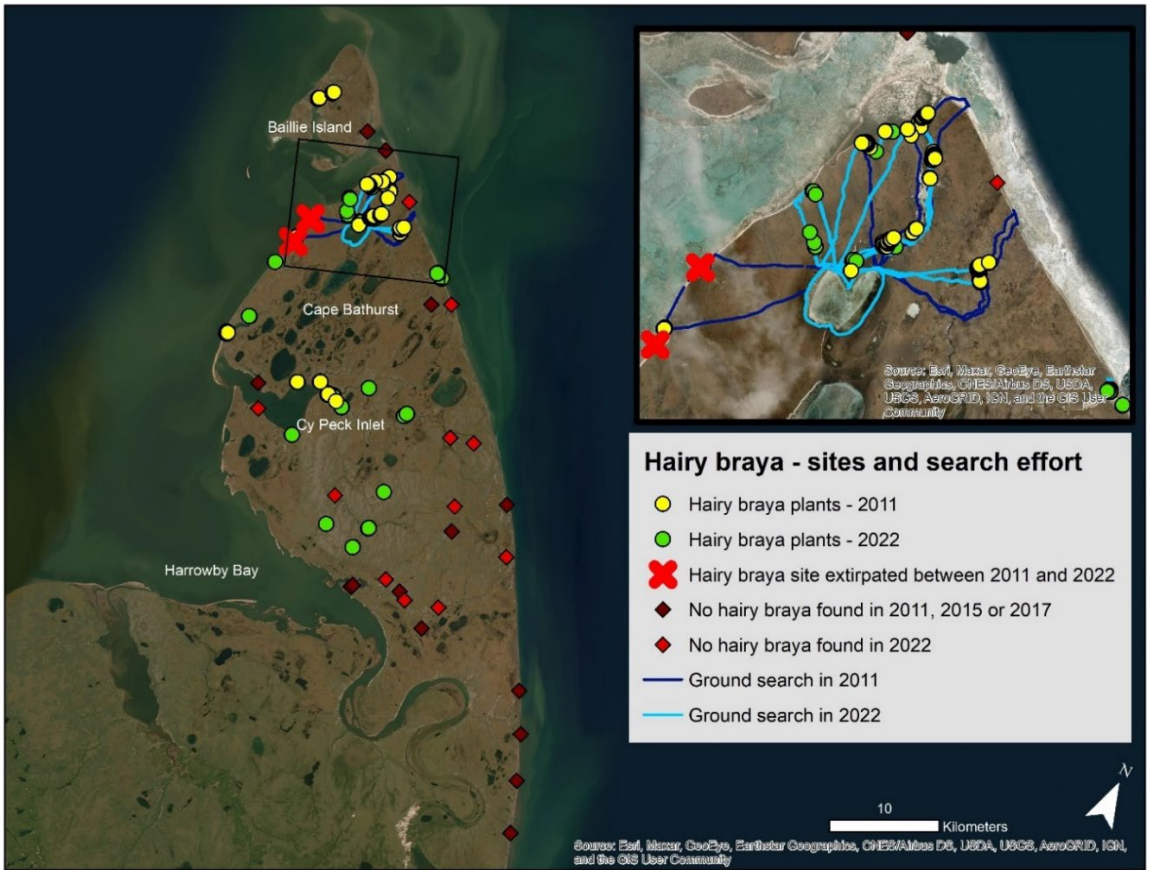

Figure 10. Search effort for hairy braya on Cape Bathurst peninsula and Baillie Islands in 2011 (Harris 2011), 2015 (Bennett, pers. comm. 2015), 2017 (Sokoloff pers. comm. 2022), and 2022 (Wilson *et al.* in prep.). Map Courtesy of J. Wilson, ECC.

In August 2015, Bruce Bennett visited some sites on the northeastern side of Cape Bathurst Peninsula, and at North Star Harbour, as part of a biodiversity inventory in association with NRCan. He searched for hairy braya at those places but did not find any. He also revisited the original hairy braya site at element occurrence k and found that the coast had eroded about 100 m inland, and the number of hairy braya plants was much less than in 2011 (Bennett pers. comm. 2021).

In September 2017, as part of the Canada C3 expedition, Paul Sokoloff briefly visited two sites on the shore of Baillie Islands to search for hairy braya but did not find any (Canadian Museum of Nature 2023 and Sokoloff pers. comm. 2022).

For nine days in mid-August of 2022 (five days on foot and 4 days by helicopter), J. Wilson, P. Sokoloff, J. Harris, F. Dillon, and T. Rinner revisited all of the element occurrences of hairy braya identified in 2011 to check their status, searched for additional element occurrences within the extent of occupancy identified in 2011, and extended search efforts in the interior of the peninsula south to approximately 70.25 degrees north near North Star Harbour (Figure 10). This extended search revealed that hairy braya plants appear to be broadly distributed on dry interior uplands between Cy Peck Inlet and North Star Harbour.

Although targeted searches for hairy braya since 1850 are limited to a search in 2004 (Harris 2004), 2015 (Bennett pers. comm. 2015), 2017 (Sokoloff pers. comm. 2022) and fieldwork conducted in 2011 and 2022, the fact that hairy braya has not been found anywhere but on Cape Bathurst Peninsula and Baillie Islands is almost certainly not due to insufficient botanical exploration in surrounding areas. In addition to A.E. Porsild's significant number of collections of *Braya* between the mouth of the Mackenzie River and Cape Parry and on Banks Island, extensive botanical work has been conducted to the east of the Mackenzie River in coastal Yukon and Alaska (Bennett pers. comm. 2012). In fact, collections of other species housed in the herbaria of the Canadian Museum of Nature, Agriculture and Agri-Food Canada, the University of Alberta, the University of Alaska, the New York Botanical Garden, and the Royal Botanic Gardens at Kew, UK come from numerous places spread along the coast both east and west of Cape Bathurst and on Banks and Victoria Islands (Figures 11 and 12). None of these collections include hairy braya from anywhere except Cape Bathurst Peninsula.

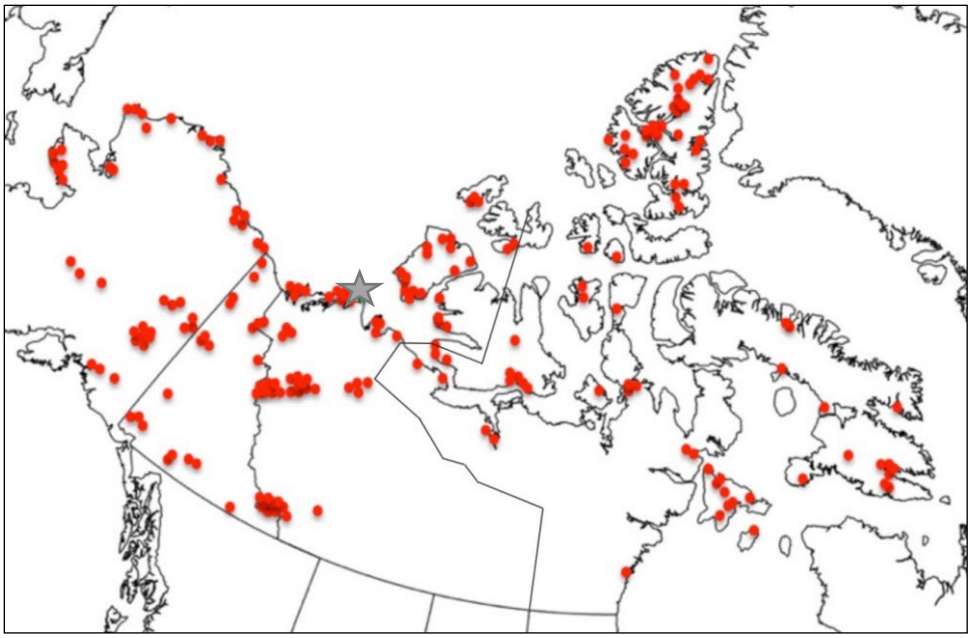

Figure 11. Hairy braya on Cape Bathurst (grey star and green dot) and other *Braya* collections (red dots) from Alaska, Yukon, NWT, and Nunavut (red). Map by J. Harris, adapted from Harris 1985.

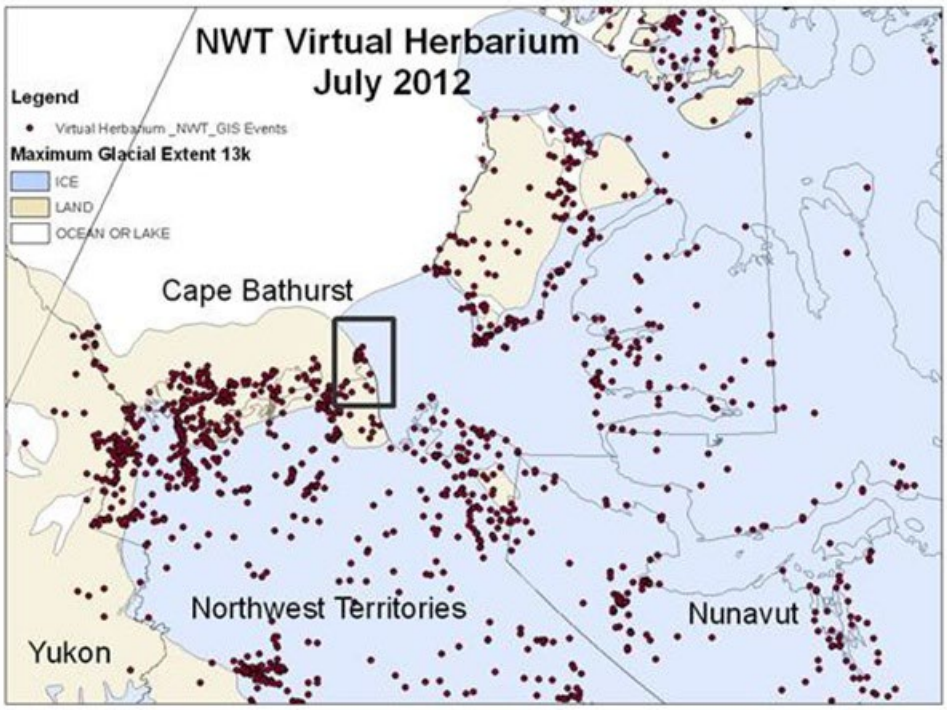

Figure 12. Collections of vascular plants in Yukon, NWT, and Nunavut (red dots), showing Cape Bathurst (rectangle) and extent of glaciation during Wisconsin maximum in northwestern North America (blue). Plant data are from NWT Virtual Herbarium (accessed July 2012) which contains label information from specimens in Agriculture and Agri-Food Canada herbarium, Canadian Museum of Nature herbarium, University of Alaska herbarium, and uncurated herbaria in Inuvik, NWT. Ice extent based on Dyke *et al.* (2003). Map by S. Carrière, Environment and Natural Resources.

Distribution Trends

Trends in the distribution of hairy braya are uncertain. However, because the only known populations of the plant are limited to an area that escaped Pleistocene glaciation (Prest 1969, Dyke *et al.* 2003) but which was surrounded by glaciated lands (Figure 13), range expansion is unlikely. In order to establish new subpopulations of the species on unglaciated lands, at least two rare seed dispersal events to the same area must occur to allow these apparently out-crossing plants to produce offspring. At the same time, rapid coastal erosion is occurring on Cape Bathurst peninsula and Baillie Islands (See Threats Section). Available habitat for the species on eroding coastlines is declining, but inland habitat appears to be stable.

Figure 13. Extent of the ice at the last glacial maximum, from Dyke *et al.* (2003). The green dots represent individual hairy braya plants. Map Courtesy of M. Routh and N. Wilson, ECC.

Movements

Movements of hairy braya populations have not been determined. However, the fact that the species is restricted to a relatively small area of unglaciated land suggests that it is not capable of moving into surrounding areas. Although no *Braya* species have seeds adapted for long-

distance dispersal, the inability of hairy braya to expand its range is more likely due to its requirement for cross-pollination and its need for stable (i.e., unglaciated) long-term habitats (see Physiology and adaptability), since other *Braya* species are widely distributed in areas that were glaciated (Figure 11). It is to be expected that hairy braya will continue to be limited to the Cape Bathurst peninsula and Baillie Islands for the foreseeable future.

Habitat Requirements

Hairy braya is restricted to an area that remained ice-free during the Pleistocene (Prest 1969; Dyke *et al.* 2003; Harris 2004). Like other *Braya* species, hairy braya is a calciphile (a plant that grows on soils rich in calcium carbonate), occurring on bluffs and dry uplands composed of calcium-rich sandy loam and silty clay loam soils (Harris 2011; Figures 14 and 15). The plant communities in which hairy braya is most commonly found are dominated by Arctic willow (*Salix arctica*), entire-leaved mountain-avens (*Dryas integrifolia*), and various grass species including Richardson's red fescue (*Festuca richardsonii*), violet wild rye (*Elymus violaceus*), Arctic bluegrass (*Poa arctica*), and alkali grasses (*Puccinellia* spp.) (Harris 2004, 2011). This plant community type falls under the Mid-Arctic Dwarf Shrub Tundra Vegetation Zone (Baldwin *et al*. 2020).

In 2022, hairy braya plants were found growing in a different plant community type (though still under the Mid-Arctic Dwarf Shrub Tundra Vegetation Zone) in upland areas in the interior of the peninsula. These communities were dominated by mouse-tail bog sedge (*Carex myosuroides*) with somewhat lesser amounts of Arctic willow and entire-leaved mountain-avens than in "typical" communities (Wilson *et al.* in prep.). Because only a few of these plant communities have been spot-checked by helicopter, and because these communities are likely rather extensive on the Cape Bathurst peninsula, it is possible that a significant portion of hairy braya individuals inhabit them.

Like other *Braya* species, hairy braya appears to be a poor competitor, requiring bare soil to become established and to thrive. In some cases, areas of bare soil occupied by hairy braya are the result of the erosion of coastal bluffs, and in other cases they are caused by disturbance due to caribou and muskox hooves and to grizzly bear digs. However, most commonly bare soils supporting hairy braya appear to be the result of seasonal periods of standing water that eliminate most other plant species from small depressions in otherwise dry habitats. Percent cover measurements were taken from three mountain avens/Arctic willow-dominated hairy braya sites in 2011. The percentages of bare soil in these three sites ranged from 39% to 47% (Harris 2011). Percent cover measurements taken in 2022 from a sedge-dominated hairy braya site in the interior of the peninsula found bare soil percentages of 5% to 70% with a mean of 34% (Wilson *et al.* 2022). Once established, mature hairy braya plants can withstand some encroachment by other plant species (Harris *et al.* unpubl. data 2011; Wilson *et al.* in prep.).

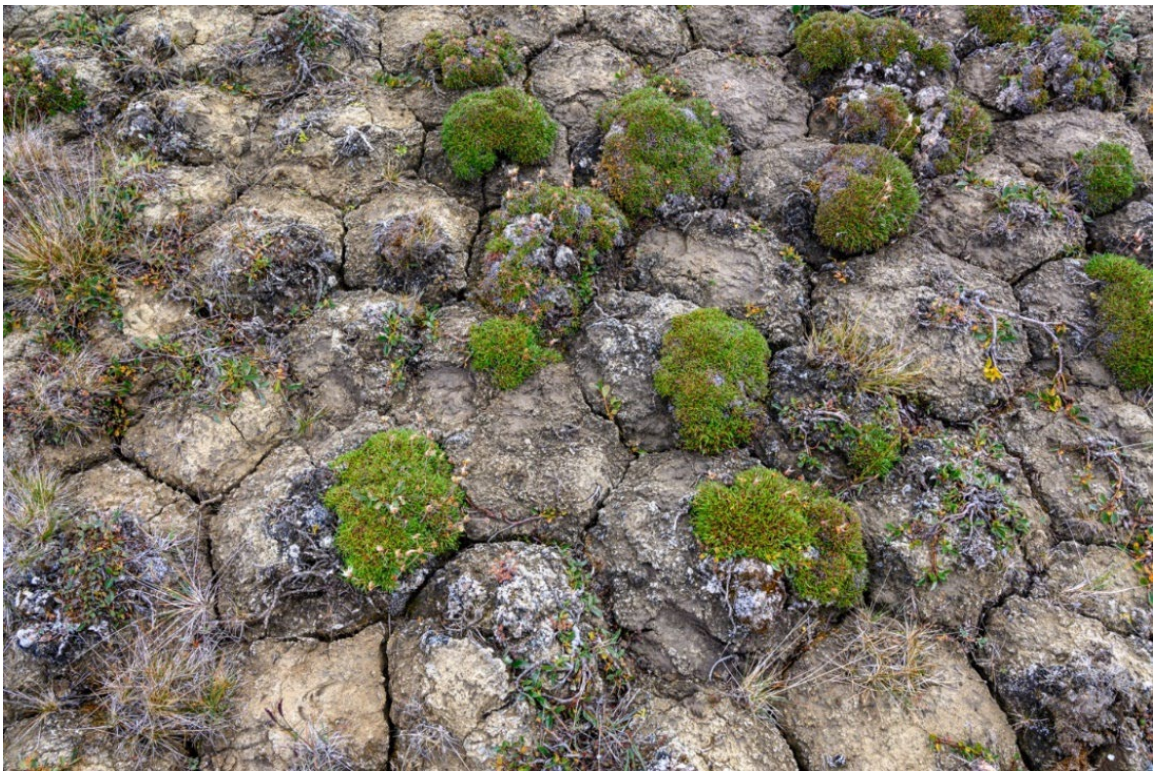

Figure 14. Typical mountain avens/Arctic willow-dominated hairy braya habitat, photo by James G. Harris, 2022.

Figure 15. Sedge-dominated hairy braya habitat, photo by James G. Harris, 2022.

Habitat Availability

Coastal bluffs and dry uplands in unglaciated areas on Baillie Islands and Cape Bathurst Peninsula north of 70.25 degrees north and on Baillie Islands potentially harbour populations of hairy braya (Figure 16). High-resolution satellite imagery indicates that these kinds of habitats total approximately 94km² (Wilson *et al.* 2022). A significant percentage of the suitable habitats in the northern and north coastal parts of Cape Bathurst Peninsula were searched for the plant in 2011 (Harris 2011) and 2022 (Wilson *et al.* 2022), but the extensive areas of potential habitat in the southern interior portions of the known range of the plant, as well as potential habitat on Baillie Islands, could only be spot-checked (Wilson *et al.* 2022). Seemingly suitable habitat examined on the eastern side of the peninsula south of 70.50 degrees north was not occupied by hairy braya (Harris 2011; Wilson *et al.* 2022). This may be because the exact limits of glaciation are unclear, and it is possible that much of the eastern side of the peninsula was either glaciated, or the periglacial environment along the margins of the glaciers was not appropriate for hairy braya. In addition, loss of habitat due to coastal erosion of unknown rate and soot deposits from oil shale fires that have been burning along the eastern banks of the peninsula at least since 1826 (Richardson 1828) may have eliminated hairy braya from the area.

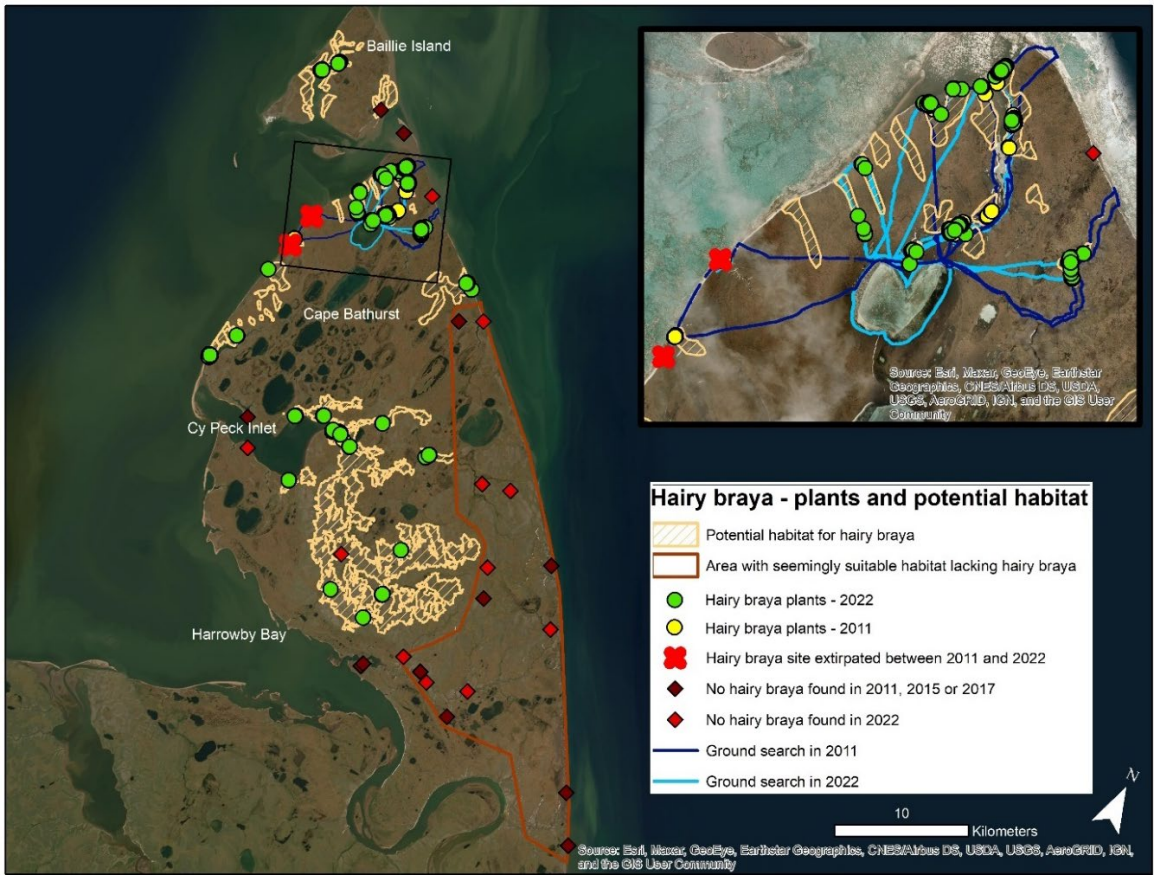

Figure 16. Potential habitat for hairy braya on Cape Bathurst peninsula and Baillie Islands. Map Courtesy of J. Wilson, ECC.

Habitat Trends

Coastal areas of Cape Bathurst peninsula and Baillie Islands are eroding rapidly, with large mats of turf, some bearing hairy braya individuals, sliding down steep escarpments toward the sea (Figures 17, 18, and 19; Harris *et al.* unpubl. data 2011; Wilson *et al.* in prep.). The well documented decrease in arctic sea ice over the past few decades (Lindsay and Zhang 2005; Stroeve *et al.* 2007) has increased the duration and severity of storm surges (Jorgenson and Brown 2005; Jones *et al.* 2009; Lantuit *et al.* 2011). Coastlines of the Beaufort Sea are experiencing some of the highest erosion rates in the Arctic (Berry *et al.* 2021), hastening the elimination of hairy braya habitat along the coast.

Figure 17. Eroding hairy braya habitat southwest of Cape Bathurst, photo by James G. Harris, 2004.

Figure 18. Northwest bank of Baillie Islands showing melting of ice-rich permafrost and bank slumping into the Beaufort Sea. Photo by Suzanne Carrière, ECC, 2011.

Figure 19. Coastal erosion near the type locality of hairy braya southwest of Cape Bathurst. Coastal retreat completely eliminated the plant from this occurrence site sometime between 2011 and 2022. Photo by Paul Sokoloff, Canadian Museum of Nature, 2022.

A recent study by Manson *et al*. (2019) looked at the sensitivity of Canada's coastlines to physical change due to the geomorphic characteristics of the coast (e.g., the nature of coastal material, presence of permafrost, and backshore slope) acted upon by forcing affects related to climate change (e.g., sea level rise, increased wave height due to a reduction in sea ice and an increase in storm severity and melting of permafrost). The highly erodible fine sediments and the large amount of permafrost subject to melting and erosion that make up much of the Cape Bathurst coastline, coupled with an expected large increase in sea level and wave height in the region, combine to place coastlines in the area in the highest Coastal Sensitivity Index (CSI) category in the study. In fact, results of the study indicate that the coastlines of Cape Bathurst Peninsula and Baillie Islands (like those along much of the Beaufort Sea) are currently among the most sensitive in Canada to the impacts of climate change and that a "large increase" in coastal sensitivity is expected through the year 2090 (Manson *et al*. 2019).

Other studies corroborate the conclusions of Manson *et al*. (2019) while providing more recent and finer resolution data about coastal erosion rates on Cape Bathurst Peninsula and Baillie Islands (Figures 20, 21 and 22).

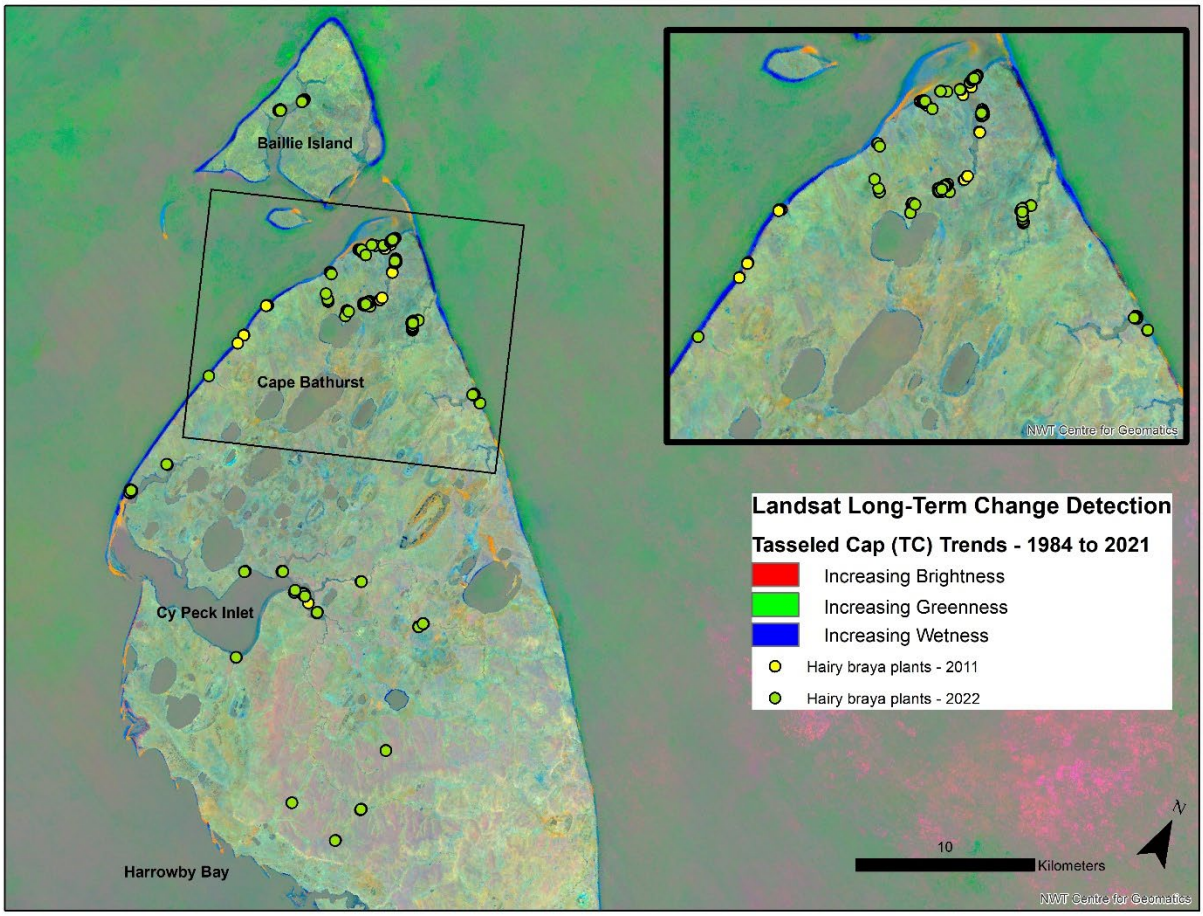

Figure 20. Long-term Change Detection dataset based on the best available Landsat scenes from 1984 to 2021. A Tasseled Cap analysis was used to develop brightness, greenness and wetness indices to illustrate landscape change (NWT Centre for Geomatics 2021 a,b). The dark blue areas along the coastline show a trend of increased wetness, indicating shoreline erosion. Map courtesy of J. Wilson, ECC. The dataset can be viewed in more detail through an online map at https://experience.arcgis.com/experience/2effc9c8150a4abebdc9ef587865ab8e.

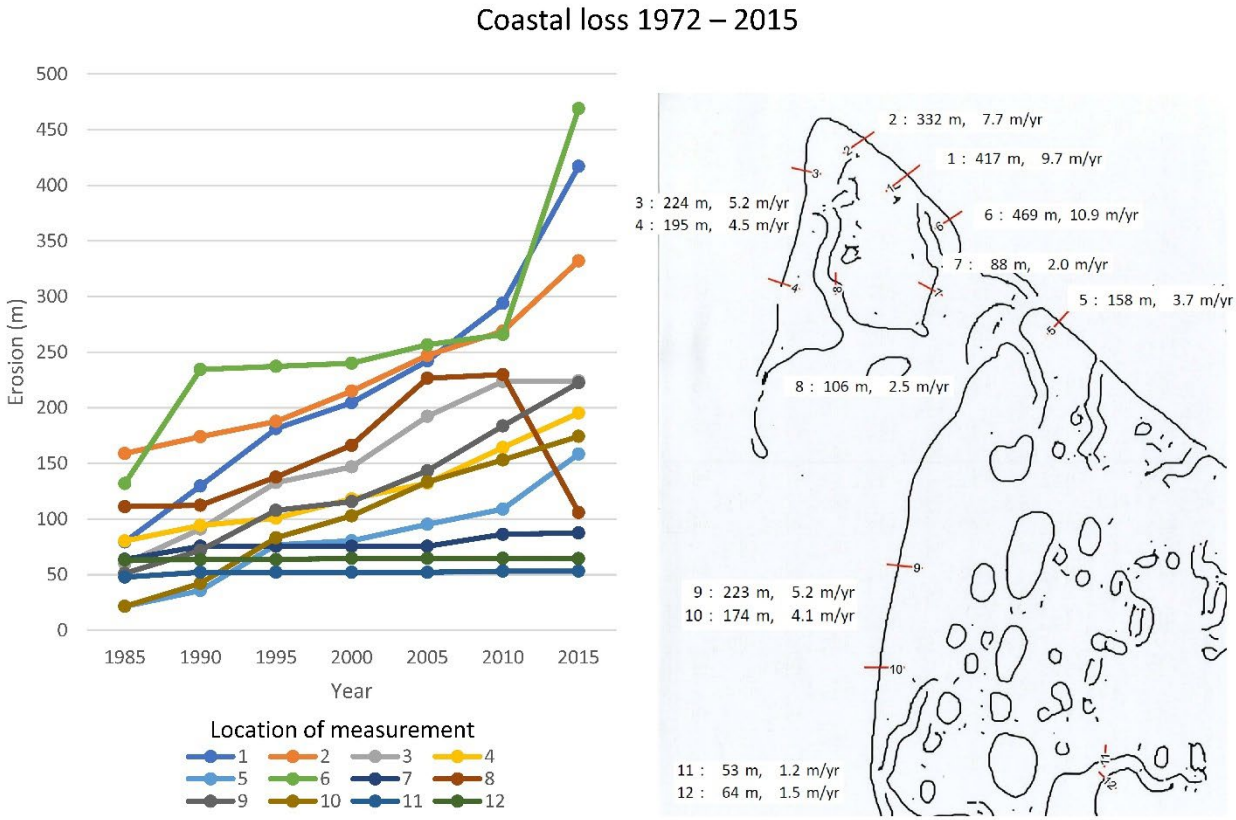

Figure 21. Coastal erosion was estimated at twelve places on Cape Bathurst Peninsula and Baillie Islands (B). Landsat imagery at five-year intervals was symbolized to show the land/water boundary, and the distance was measured to the land/water boundary in 1972. The measured distance between the coastline in 1972 and in the later image was inferred to be the amount of coastal erosion between the dates (A). Landsat imagery has 30 m pixel size therefore measurement involved some subjective interpretation of where the land/water boundary was located. Total coastal loss to 2015 and overall rate (total loss over 43 years) measured at each place is shown in (B). Coastal erosion is typically subject to high interannual variability. Erosion analysis courtesy of S. Schwarz, NWT Centre for Geomatics, March 2020. Figure courtesy of J. Wilson, ECC.

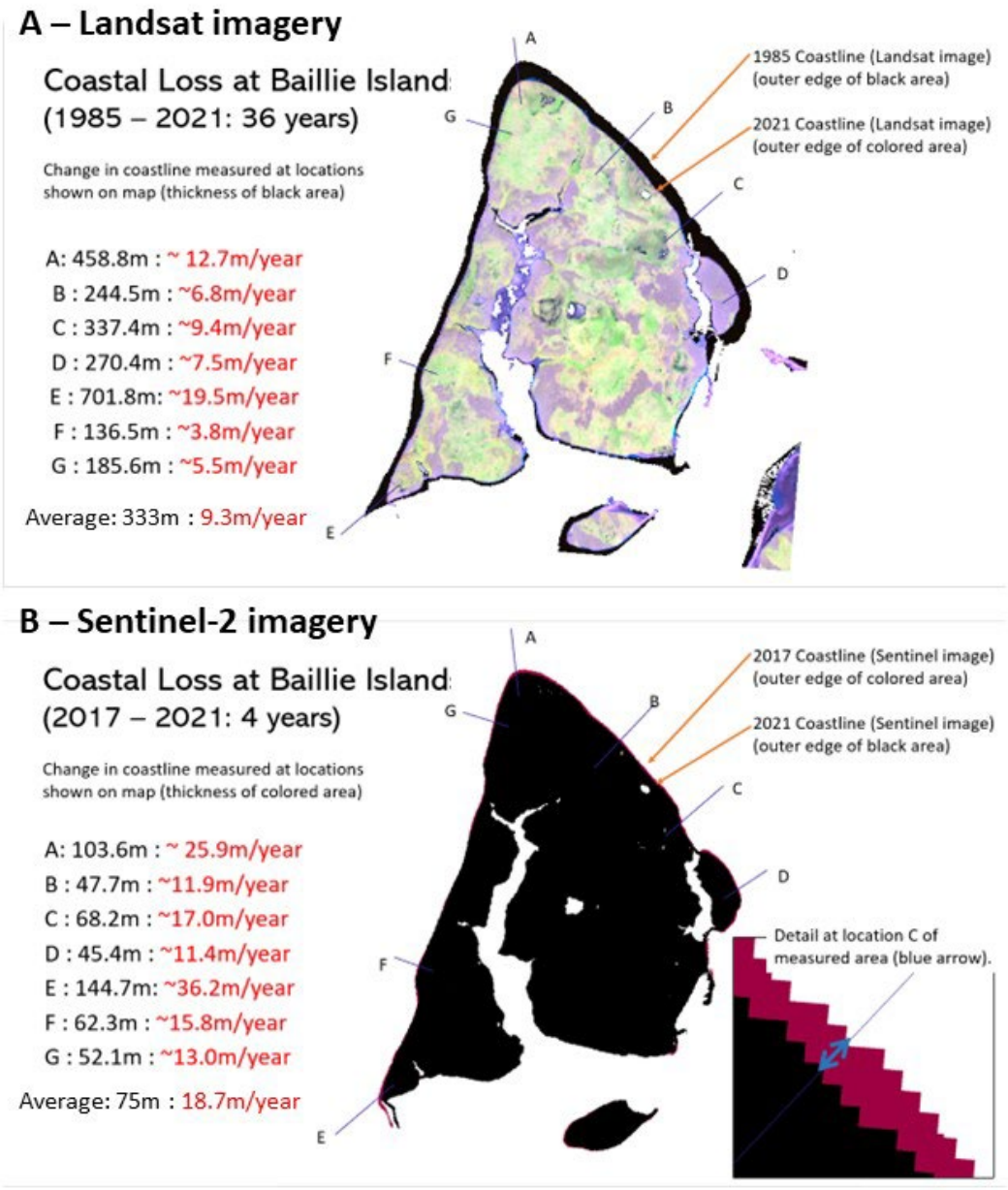

Figure 22. Coastal erosion was estimated at seven places on Baillie Islands by comparing an early and later (most recent) satellite image. The measured distance between the coastlines of the earlier and later image was inferred to be the amount of coastal erosion between the dates of the images. Landsat imagery (A) is moderate resolution (30 m) and was available 1985-2021. Sentinel-2 imagery (B) is higher resolution (20 m) and was available for 2017-2021. Satellite imagery is pixelated, therefore measurement involved some subjective interpretation of the where the land/water boundary was located. The difference between the two results could be caused by differing erosion rates over the two time periods and/or the coarser pixel size of the Landsat imagery. Online mapping tool, erosion analysis and figure courtesy of S. Schwarz, NWT Centre for Geomatics, April 2023.

Inland habitats of hairy braya, as well as habitats along coastal inlets more protected from ocean waves, appear to be relatively stable (Harris 2011; Wilson et al. 2022) (Figures 20 and 21). Fortunately, most individuals of the species are growing in these more stable habitats.

Since at least some habitat is associated with soil disturbance due to caribou hooves (see the section on Habitat requirements), it is reasonable to assume – although it has not been confirmed – that declines in caribou numbers may reduce hairy braya habitat. Caribou numbers in the Cape Bathurst region have declined in recent decades (Nagy and Johnson 2006) but have recently shown a slight increase (Environment and Natural Resources 2022b).

Habitat Fragmentation

Habitat suitable for hairy braya exists as bluffs along coastlines, inlets, and streams and in other dry uplands. In the northern portion of the range, these islands of habitat are often separated from other suitable habitat by large areas of wet tundra; in the southern interior, habitat appears to be more extensive and continuous (Figure 16). In addition, strips of potential habitat along the coast can be fragmented by erosion or salinization (increased salt concentrations in the soil) due to sea spray and storm waves overtopping coastal bluffs (Figure 23; Harris *et al.* unpubl. data 2011). For example, two occurrences of hairy braya that existed in 2011 were eliminated sometime before 2022 due to coastal erosion and/or salinization (Figure 16), significantly increasing the distance between some extant occurrences along the coast. Fragmentation of hairy braya distribution and habitat along coastlines likely has been occurring for many decades and it can be expected to accelerate as climate change advances (see Habitat Trends section).

The ability of hairy braya to disperse between patches of suitable habitat is unknown, but neither the fruits nor the seeds of the plant are adapted for long-distance dispersal (see the section on Movements). As hairy braya occurrences are lost along the coasts, it seems highly unlikely that any remaining suitable habitat there can be colonized (or recolonized) at a rate that is fast enough to stay ahead of erosion. As a result, the break in distribution between hairy braya occurrences in the northern part of Cape Bathurst Peninsula and those farther south is increasing.

While many hairy braya element occurrences are isolated from one another, they usually consist of fairly large numbers of individuals (typically from 100 to more than 10,000) and therefore would probably not be correctly characterized as "severely fragmented" as defined by SARC (2010).

Figure 23. Northwest bank of Cape Bathurst with salinization mortality. Photo by Suzanne Carrière, ECC, 2011.

POPULATION

Abundance

In this report, population refers to the total number of all hairy braya plants. Precise counts of the number of hairy braya individuals (plants arising from a single root) are not possible, and even reliable estimates are difficult to determine. J. Harris, P. Sokoloff and J. Wilson developed a population estimate based on the number of individual plants observed in 2022 (Table 1), the apparent density of the populations they were found in, and the amount of potential habitat observed in close proximity to these observations. This estimate based on expert opinion was about 25,000 to 50,000 individuals. They then developed an alternate population estimate using plant density (number of plants observed in 2022 by area of ground search; Table 2) extrapolated to the total area of potential habitat as determined from satellite imagery (Figure 16). This estimate derived using quantitative methods was about 983,000 individuals (Table 2).

The second result is almost certainly an over-estimate of actual abundance because it assumes plant density at the surveyed site(s) reflects density in the entire potential habitat patch, but field surveys sometimes targeted areas that looked like the most promising habitat. However, it does suggest that other estimates based on expert opinion were too low and probably did not adequately reflect the large number of hairy braya plants growing on dry uplands in sedge-dominated habitat, as was learned in 2022. It also highlights the need for further work in the southern interior of Cape Bathurst peninsula and on Baillie Islands, areas which have been less surveyed but where there is a large amount of potential habitat for hairy braya.

Given the above, a reasonable estimate for population size would range from 50,000 to 983,000.

Because hairy braya appears to reach reproductive maturity in a single season, as is the case in other North American *Braya* species, it is assumed that all individuals are capable of reproduction, even though a significant percentage of individuals (or separate stems arising from a common root crown) may remain vegetative in a given season.

Table 2. Hairy braya abundance estimates calculated using quantitative methods (Wilson *et al.* in prep.).

Subpopulation	Estimated Density (plants / 100 m²)	Area of potential habitat (km²)	Estimated number of plants
Baillie Islands	2.1	8.4	174,000
Northern Cape Bathurst	1.0	10.5	102,000
Northwest Coast	0.5	5.2	27,000
Southern Interior	1.0	70.3	680,000
Total:	-	**94.4**	**983,000**

Population Dynamics

Little is known about the population structure and demographics of hairy braya. Plants of varying ages and sizes occur in every element occurrence examined in 2011 (Harris *et al.* unpubl. data 2011) and 2022 (Wilson *et al.* in prep.), indicating that seedlings are being recruited successfully. However, there is a striking difference in vigor between plants from different habitats.

In general, hairy braya individuals on broken and eroding bluffs along coastlines, inlets and streams tend to be more robust and reproductively successful than those on more stable inland habitats (Wilson *et al*. 2022). As these bluffs erode, the turf at the edge of the bluff often splits into deep fractures and crevices as it is undercut by erosion and permafrost thawing and begins to break away (Figure 24). The newly exposed soils in these fractures and crevices are less compacted, perhaps allowing better root penetration than soils elsewhere, they lack most other plants that might compete with hairy braya, and they likely harbour nutrients previously unavailable due to their deeper position in the soil column. In addition, surficial soils in eroding coastal areas demonstrate a temperature gradient, with soils near the coast being warmer than those just a few meters inland (D. Whalen and M. Lim per. comm. 2022). Likely as a result of some combination of these factors, hairy braya plants on these fissured bluff habitats tend to be large with many flowering and fruiting stems, and the ratio of reproductive to vegetative individuals is high.

Figure 24. Eroding, fractured coastal bluffs exposing high-quality hairy braya habitat. Photo by James Harris 2022.

In contrast, hairy braya plants on more stable inland habitats tend to be much smaller on average, with fewer flowering and fruiting stems, and the percentage of individuals producing flowers and fruits in a given year is significantly lower. This is probably due to the higher degree of competition hairy braya faces in these habitats as well as to a lack of some of the other potentially favorable features of bluffs described above. Notably, the largest and most productive hairy braya plants in these inland areas are often growing on grizzly bear digs, microhabitats that mimic some of the conditions on eroding bluffs (Wilson *et al*. 2022). It has been shown that grizzly bear digs, in addition to eliminating competing plant cover, can raise soil nutrient levels (Tardiff and Stanford 1998).

The density of hairy braya populations is unique among North American *Braya* species. In almost every instance, most *Braya* species occur as scattered individuals across large areas rather than in dense populations. For example, both smooth braya (*Braya glabella*) and low braya (*Braya humilis*) are found on the Cape Bathurst peninsula, but they never occur in large or dense populations. During fieldwork conducted on Cape Bathurst in 2011 and 2022, perhaps 100-200 smooth braya individuals in total were encountered, and less than 10 individuals of low braya were seen. In contrast, hairy braya populations are often comprised of hundreds or even thousands of individuals distributed over a limited area. The average density of the 17 extant hairy braya EOs has been estimated to be about 1.2 plants/100 m^2 (Wilson *et al.* 2022; Table 1). Perhaps the size and density of many hairy braya populations is another indicator that the species is likely outcrossing. It has been noted (Karron 1995) that the reproductive success of outcrossing plant species is higher in denser populations where the transfer of pollen is facilitated by the close proximity to other members of the species.

Trends and Fluctuations

The estimated number of hairy braya plants in 2022 (Wilson *et al*. 2022) is much higher than the estimate in 2011 (Harris et al. unpubl. data 2011). This is not due to an increase in the actual population but rather to a significantly expanded search effort in 2022 that led to the discovery of new element occurrences (See Search Effort section).

Hairy braya populations on coastal bluffs subject to rapid erosion have declined and are clearly at risk of further declining (see section on Habitat trends). The total number of individuals at the one coastal site that was visited in both 2004 and 2011 (element occurrence k) plummeted from several hundred to approximately 100 individuals over that seven-year period (Harris 2004; Harris *et al.* unpubl. data 2011). When the same site was visited in 2015, only about 80 hairy braya plants were found (Bennett pers. comm. 2021). By 2022, this and one other coastal hairy braya site had been completely extirpated because of erosion of habitat (Wilson *et al.* 2022). It can be expected that similar subpopulations on eroding shorelines will be similarly impacted. Of the 17 known extant element occurrences of hairy braya, seven are at least partially located in these

at-risk habitats within one kilometre of the coast (Figure 7 and Table 1, Location 1). Based on a generation time estimate of 5-7 years, 3 generations would be 15-21 years. At the upper estimate of coastal erosion (10 metres per year), about 150-210 metres of hairy braya habitat along the cost would be lost over the next 3 generations. This amount of erosion would likely impact 5 of the 17 extant EOs. Two EOs (l & i) would be lost entirely, and 3 (q, g, and o) would be greatly reduced. However, because the overwhelming majority of hairy braya individuals are not found along the coast, the percent reduction in the total number of individuals would be less than 1%. Trends and fluctuations in subpopulations on protected sections of the coast and on inland bluffs have not been determined precisely, but they appeared to be stable when examined in summer 2011 (Harris *et al.* unpubl. data 2011) and then again in 2022 (Wilson *et al.* in prep.).

Because hairy braya plants apparently reach maturity in a single season, there is no evidence that hairy braya populations typically experience extreme fluctuations in the number of mature individuals. However, not all mature individuals reproduce every year. It is common to find hairy braya plants that did not flower or fruit in the year observed that bear remnants of fruiting stalks from a previous year. As previously noted, populations of hairy braya may differ significantly from one another in the ratio of reproductive to vegetative individuals in a given season, most likely due to differing levels of competition with other plant species.

Recovery actions

Since the first SARC assessment of hairy braya in 2012 (SARC 2012), work on recovery planning and implementation for the species has progressed. Hairy braya was listed under the *Species at Risk (NWT) Act* as a Threatened species in the NWT in 2014. The NWT Conference of Management Authorities (CMA) completed the Recovery Strategy for Hairy Braya (*Braya pilosa*) in the Northwest Territories (CMA 2015) and an agreement respecting the implementation of the recovery strategy (CMA 2016). The CMA published a progress report on the conservation and recovery of hairy braya (2017-2021), and meets to review progress on recovery actions and current information on population and habitat annually (CMA 2022).

At the national level, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed hairy braya as Endangered in Canada (COSEWIC 2013) and the species was listed as Endangered under the federal *Species at Risk Act* (SARA) in 2018 (Reference: SARA registry). A federal recovery strategy, which includes an adoption of the NWT recovery strategy with the addition of critical habitat identification, was finalized in 2022 (ECCC 2022).

The 2022 population survey, collection and storage of seeds at the Millennium Seed Bank, and erosion monitoring have taken place as discussed earlier in this report. Additionally, the hairy braya genome was sequenced and submitted to a gene bank to conserve genetic information (CMA 2022). The genome sequence was also provided to the Inuvialuit Regional Corporation (Parrott pers. comm. 2023). In 2022, conservation scientists designated the hairy braya range as

a Key Biodiversity Area - a site that contributes significantly to the global persistence of biodiversity (KBA 2023). This designation helps to focus public attention on a particular site, but does not affect ownership or provide habitat protection.

Communications about hairy braya have increased over the last decade, raising awareness of the species among Inuvialuit as well as the public at large, and focusing attention on its conservation needs. Increased awareness helps to build support for recovery actions and can be important for preventing future human impacts on the species. For example, the NWT Species at Risk Secretariat developed a fact sheet about hairy braya highlighting the importance of biodiversity conservation (SARS 2019). Discussions about hairy braya took place with the ILA and THTC as part of the planning and reporting for the 2022 survey, a hairy braya plant specimen sheet was provided to the Inuvialuit Regional Corporation (IRC) for their Inuvik office, and a trip report about the survey was shared with Inuvialuit organizations (Wilson *et al.* 2022). The 2022 survey sparked media attention on news outlets and social media (e.g., Canadian Museum of Nature 2023, CBC 2023). Information about hairy braya was shared at scientific conferences (ArcticNet 2022, Sokoloff *et al.* in prep) and at public events at the Canadian Museum of Nature in Ottawa (open house October 2022, Arctic Biodiversity symposium March 2023, P. Sokoloff pers. comm.) Ecology North delivered hairy braya education and awareness workshops with youth and educators in the Inuvialuit Settlement Region (Ecology North 2023a in Prep.) and developed a teacher guide and species ID card about hairy braya (Ecology North 2023b).

Sharing spatial information about hairy braya with land managers, developers and other parties can also help to prevent future human impacts. The GNWT's NWT Species and Habitat Viewer is an online mapping platform where users can easily discover and view the ranges and critical habitats of species at risk in the NWT, including hairy braya (GNWT 2023). The *Species at Risk Report Tool* on the Viewer allows the user to generate a report that identifies all the species at risk that occur within their area of interest, along with information on their status and critical habitat.

Possibility of Rescue

Hairy braya is known only from Cape Bathurst Peninsula and Baillie Islands, so there is no possibility of rescue from wild populations elsewhere. Seeds of hairy braya were collected in 2022 (20 packets of seeds from across the range, to capture the genetic variation in the species). The seeds have been placed in the Millennium Seed Bank of Kew Gardens in England for long-term storage (Wilson *et al.* 2022). In the unlikely event of the complete loss of hairy braya from the natural environment, these seeds would ensure the survival of the species.

THREATS AND LIMITING FACTORS

The most obvious threat to hairy braya is a loss of habitat due to rapid erosion of coastline habitat. Increasing rates of coastal erosion due to a significant reduction in ice cover on the Beaufort Sea over the past few decades are well documented (e.g., Jorgenson and Brown 2005; Jones *et al.* 2009; Lantuit *et al.* 2012; Kokelj *et al.* 2012; Vermaire *et al.* 2013; Greenan *et al.* 2018; Manson *et al.* 2019). Recent estimates of the rate of erosion of some coastline areas, based on high-resolution satellite imagery, indicate rapid erosion along exposed coastlines and slower erosion along inlets more protected from ocean waves (Figure 20). For example, erosion on the coast of Baillie Islands was about 9 m/year, on average, from 1985 to 2021 (Figure 22). Erosion on Cape Bathurst peninsula from 1972-2015 ranged from 1.2-1.5 m/year on the shore of Cy Peck Inlet, to 3.7-5.2 m/year on the exposed coast of Cape Bathurst Peninsula, to 2.0-10.9 m/year on the coast of Baillie Islands (Figure 21). Due to warming of the earth's atmosphere, which is expected to continue into the foreseeable future, it is expected that sea levels in the region will increase by 0.2 to 1.0 m over 100 years (Environment and Natural Resources 2022a) and protective sea ice will continue to decline (Lindsay and Zhang 2005), so coastal erosion rates will likely increase and the probability of storm surges will likely also increase. Coasts along the Beaufort Sea are especially vulnerable to climate change and sea-level rise (Shaw *et al.* 1998; Manson *et al.* 2019; Berry *et al.* 2021). (See the Habitat Trends section of this report for a more detailed discussion of the factors that make the coastline near Cape Bathurst particularly vulnerable to erosion).

Habitat along the coast can also be destroyed by salinization where sea spray and storm waves cause an increase in salt content in the soil (see Habitat Fragmentation), but the relative impact of salinization compared to erosion is not yet well understood. Habitat destruction due to salinization was apparent in 2011 (Harris *et al.* unpubl. data 2011), but this was not the case in 2022 (Wilson *et al.* in prep.). Apparently, the effects of salinization can vary over time, perhaps due to a faster rate of erosion than salinization in some years.

SARC (2012) suggested that hairy braya near Cy Peck Inlet (element occurrences e and f, Figure 7) may be in "low-lying areas" and be at risk from possible flooding events (e.g., due to storm surges). However, Wilson *et al.* (2022) noted that hairy braya was found on top of raised bluffs and uplands in these areas, like other sites. Therefore, although storm surges are certainly an important factor causing coastal erosion, the potential for flooding at these sites is no longer considered to be a more significant threat to hairy braya than it is elsewhere.

Continued warming also has the potential to increase the risk of tundra fires in the Arctic via increased lightning combined with drought conditions (Hethcoat 2024). Other threats are not known but may include stochastic events related to local changes in habitat and disturbances.

POSITIVE INFLUENCES

Remoteness and current land management

Due to the remoteness of Cape Bathurst peninsula and Baillie Islands, hairy braya faces little direct threat from human activities. Inuvialuit use Cape Bathurst and Baillie Islands for traditional land use activities such as subsistence harvesting, but the minimal amount of habitat alteration that might be caused by these activities could actually benefit hairy braya by exposing bare patches of earth that allow the species to grow (ECCC 2022). The Inuvialuit Land Administration manages a cabin registry program that keeps track of cabins and helps to determine whether future cabins could or should be built in the area (ECCC 2022).

Cape Bathurst Peninsula and Baillie Islands are part of the "Cape Bathurst selection" of Inuvialuit lands under section 7(1)(a)(ii) of the Inuvialuit Final Agreement (IFA) and described in Annex D of the IFA (Figure 25; DIAND 1984). This means that the Inuvialuit have surface and subsurface title to all the land where there is critical habitat for hairy braya. Inuvialuit private lands are managed by the Inuvialuit Land Administration, a branch of the Inuvialuit Regional Corporation. Any development activities in this area would require a Land Use Licence from the Inuvialuit Land Administration (IRC 2023). The ILA normally requires the approval of the relevant Hunters and Trappers Committee (HTC) before approving project proposals and permits, and can attach conditions on projects to ensure that land and resources are not harmed. Cape Bathurst and Baillie Islands are in the Tuktoyaktuk Conservation Planning Area so the primary community point of contact involved in these decisions is the Tuktoyaktuk HTC (Figure 25; TCCP 2016).

Section 8(6) of the IFA states that "any new subsurface development with respect to the Cape Bathurst selection shall be subject to the consent of Canada." This means that any development project for accessing resources under the surface of the land - such as mining, oil and gas, or quarrying - would not be allowed in the hairy braya range unless Government of Canada agrees.

The Environmental Impact Screening Committee (EISC 2023) and the Environmental Impact Review Board (EIRB 2023) play a role in regulating potential impacts of development on hairy braya and their habitat. In accordance with the IFA, any development is subject to screening and/or review before projects can be approved and permits issued. The EISC conducts environmental screening of development activities proposed for both the onshore and offshore areas of the ISR. The EISC determines if proposed developments could have a significant negative environmental impact. It can also decide that the development, if authorized subject to environmental terms and conditions recommended by the EISC, will have no significant negative environmental impact and can proceed without review. Where the EISC determines that the proposed development could have a significant negative environmental impact, it is

referred and subject to assessment and review by the EIRB. The EIRB carries out detailed environmental impact assessments and public reviews of development projects referred to it by the EISC. The EIRB determines whether a project should proceed and, if so, under what specific terms and conditions.

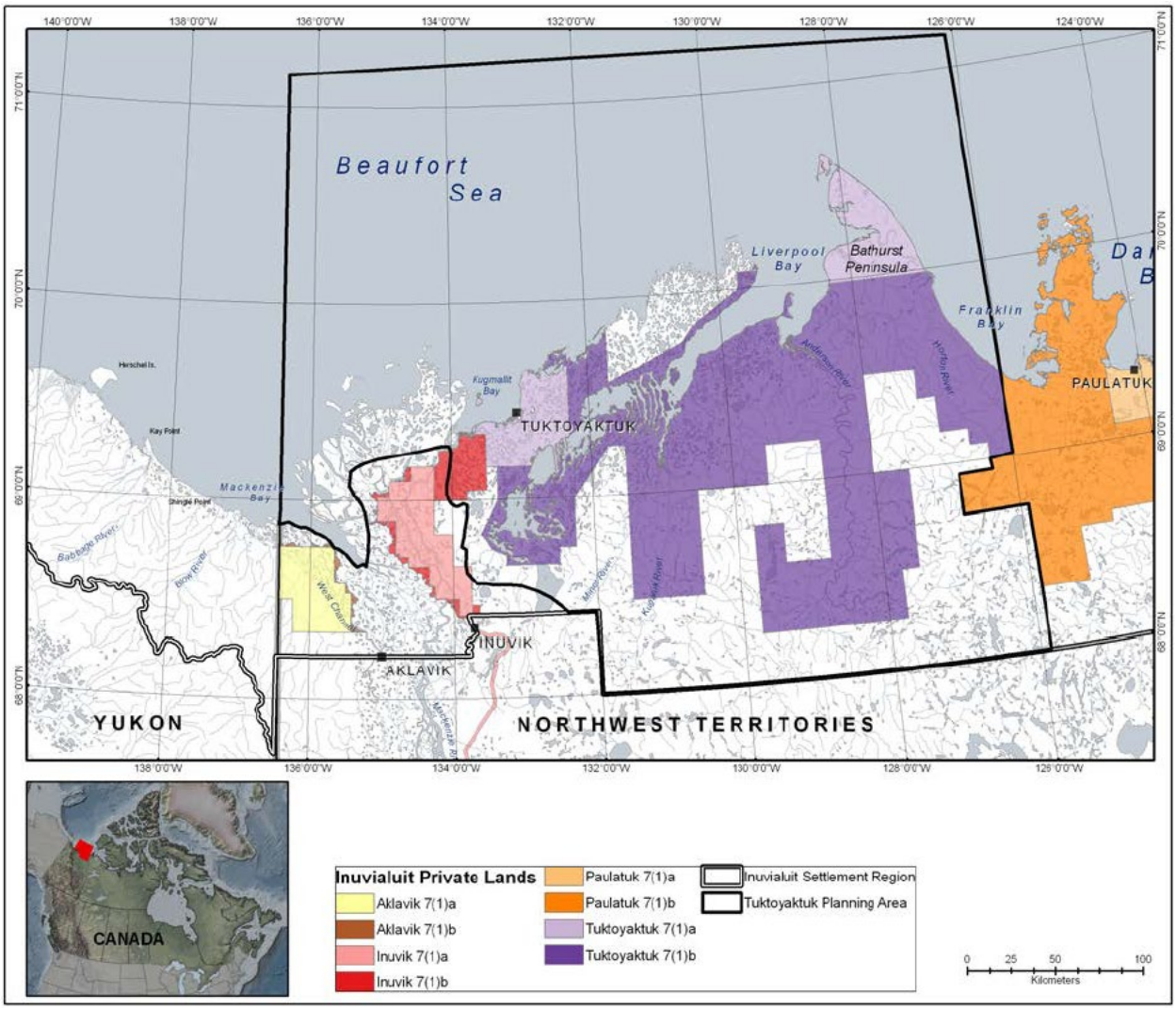

Figure 25. Map reproduced from the Tuktoyaktuk Conservation Planning Area and Private Lands identified in the Tuktoyaktuk Community Conservation Plan (TCCP 2016).

According to their Environmental Impact Screening Guidelines, the EISC requires developers to engage and consult with Inuvialuit communities and the other parties (Inuvialuit organizations, co-management organizations, and government agencies) before and during the screening process (EISC 2021). The EISC also notifies the parties of a screening underway and provides an opportunity for them to review and comment.

The Inuvialuit have developed Community Conservation Plans for the conservation and management of natural resources and lands within the ISR. Community Conservation Plans are

not legally binding but are considered by the ILA, EISC, EIRB, and other parties in deciding whether to allow activities. The conservation priorities for Cape Bathurst Peninsula and Baillie Islands are formalized in the Tuktoyaktuk Community Conservation Plan (2016).

Cape Bathurst Peninsula is a core calving and post-calving ground for the Cape Bathurst barren-ground caribou herd. For this reason, the Tuktoyaktuk Community Conservation Plan (2016) specifies a high level of conservation priority for the area. All of the mainland habitat of hairy braya is within *Site 731D: Cape Bathurst Caribou Core Calving and Post-Calving Grounds*. The plan states that it is an area where "cultural or renewable resources are of particular significance and sensitivity throughout the year" and recommends that this area "shall be managed so as to eliminate, to the greatest extent possible, potential damage and disruption" (TCCP 2016). Although this designation is intended to protect the Cape Bathurst barren-ground caribou herd and their habitat, it also indirectly protects hairy braya habitat.

Baillie Islands is not included in site 731D. It is part of a different area that is recognized as important for polar bears from October to March, *323C: Mainland Coastal Polar Bear Denning Areas*. The plan states that it is an area where "cultural or renewable resources are of particular significance and sensitivity during specific times of the year" and recommends that this area "shall be managed so as to eliminate, to the greatest extent possible, potential damage and disruption" (TCCP 2016). This designation may indirectly provide some conservation benefit for hairy braya habitat on Baillie Islands.

The Government of Canada identified critical habitat for hairy braya in the Recovery Strategy for the Hairy Braya in Canada (ECCC 2022) (Figure 26). The federal *Species at Risk Act* (SARA) requires that critical habitat be protected from destruction.

Areas containing critical habitat for hairy braya (ECCC 2022), identified under the *Species at Risk Act*, are shown in Figure 26.

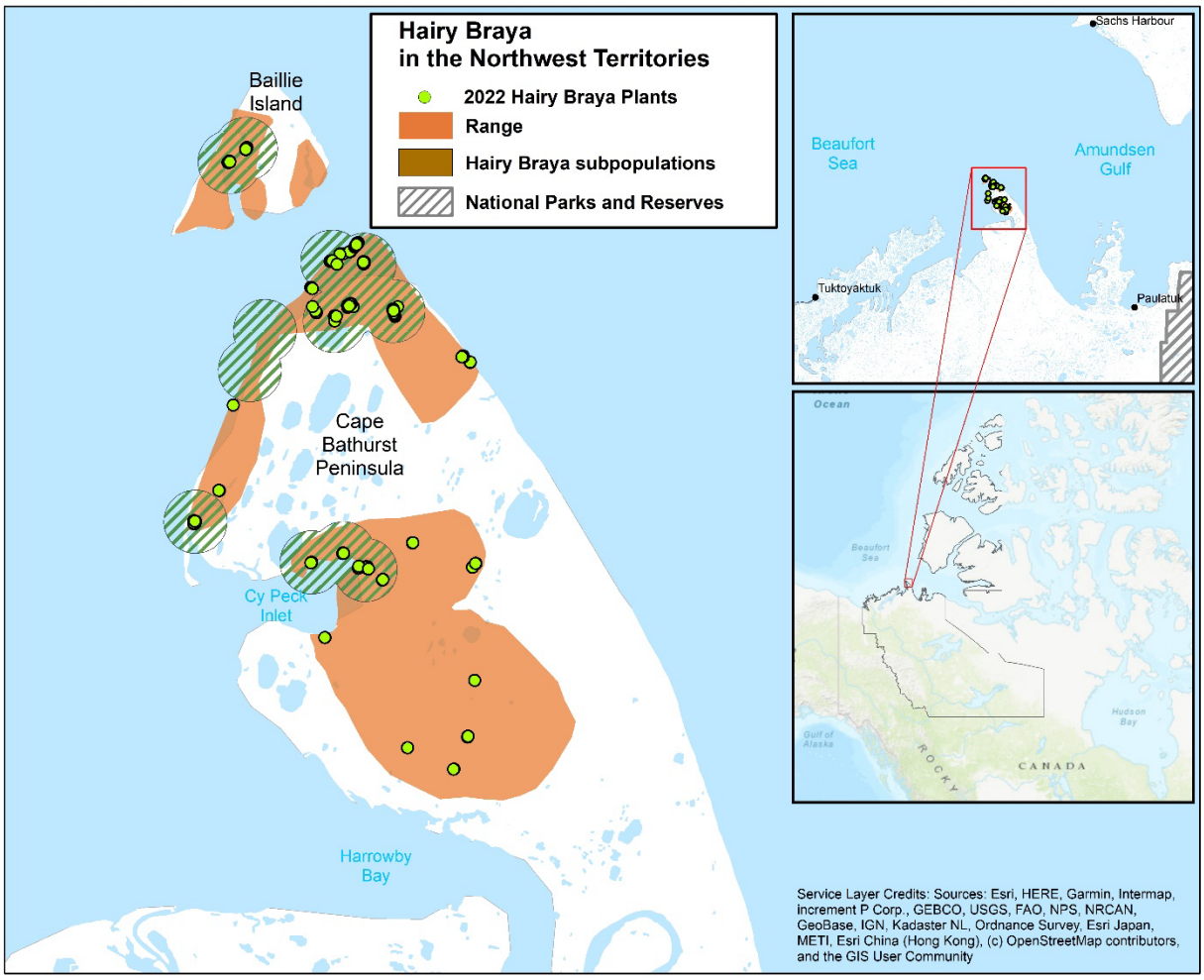

Figure 26. Within these areas shown in green, critical habitat occurs where there are the right conditions for hairy braya to grow: bluffs or dry uplands which include calcium-rich soils of sandy loam or silty clay loam, and bare soil for the plants to become established. Further details on critical habitat features, attributes, and destruction can be found in the recovery strategy (ECCC 2022). Data from Wilson *et al.* in prep. Map courtesy of N. Wilson, ECC.

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STATUS AND RANKS

Region	Coarse Filter (Ranks)[2] To prioritize	Fine Filter (Status) To provide advice	Legal Listings (Status) To protect under species at risk legislation
Global	G2 - Imperiled (NatureServe 2020)		
Canada	N2 - Imperiled (NatureServe Canada 2020)	Endangered (COSEWIC 2013)	Endangered (*Species at Risk Act* 2018)
Northwest Territories	At Risk (NWT General Status Ranking Program 2017)	Threatened (SARC 2012; 2024)	Threatened (*Species at Risk (NWT) Act* 2014)
Adjacent Jurisdictions - none			

[2] All NatureServe codes are as defined in Definitions of NatureServe Conservation Status Ranks: http://help.natureserve.org/biotics/Content/Record_Management/Element_Files/Element_Tracking/ETRACK_Definitions_of_Heritage_Conservation_Status_Ranks.htm#NatureSe

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APPENDIX A – ADDITIONAL INFORMATION

Collections Examined

Braya pilosa was collected four times prior to 2011: John Richardson *s.n.*, 1826, 1848; William Pullen *s.n.*, 1850; and James Harris and Daniel Taylor collection #3644, 2004. The Richardson and Pullen collections are located in the Royal Botanic Gardens Herbarium (K) at Kew, England, while the Harris and Taylor collection (and duplicates) are located at the following herbaria: Utah Valley University (UVSC), Agriculture and Agri-Food Canada (DAO), Canadian Museum of Nature (CAN), Missouri Botanical Garden (MO), New York Botanical Garden (NY), and University of Alaska (ALA). The preparer has examined all of these collections. Specimens collected during fieldwork conducted in 2011 and 2022 were also examined. Voucher specimens and duplicates from 2011 were deposited in the Yukon Government Herbarium (BABY) and Utah Valley University Herbarium (UVSC). Specimens and duplicates collected in 2022 were deposited in the herbarium of the Canadian Museum of Nature (CAN), the Aurora Research Institute in Inuvik, NWT, and the Utah Valley University Herbarium (UVSC).

Additional Photographs of Hairy Braya

Figure A1. [left] Flowers and fruits of hairy braya, photo by James G. Harris, 2004. [right] Fruits of hairy braya, photo by James G. Harris, 2022.

Figure A2. [left] Collection of *Braya pilosa* in the herbarium of Utah Valley University, photo by James G. Harris, 2004.

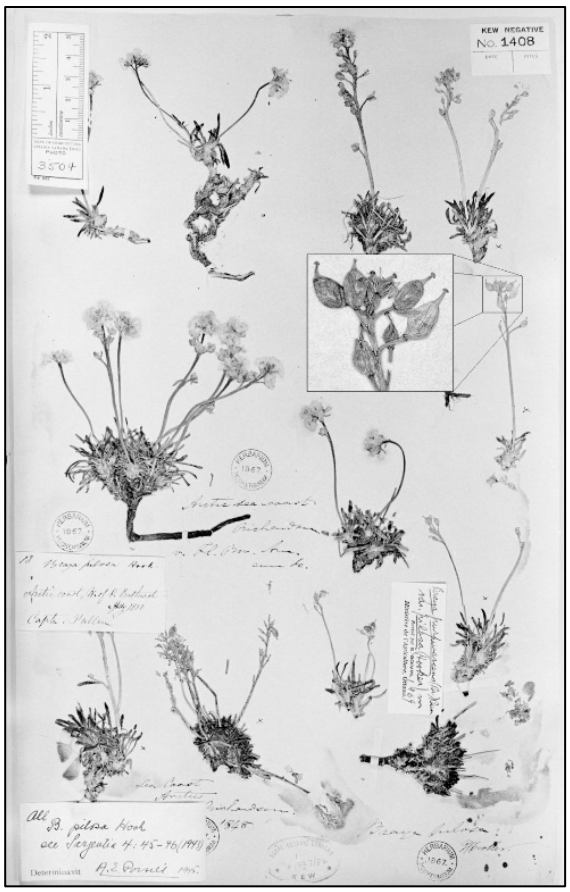

Figure A3. Type collection of *Braya pilosa*, Kew Herbarium (the annotation of one group of specimens by Boivin as *Braya purpurascens var. pilosa*, a combination that was never actually published, reflects a misinterpretation of the species). Photo by James G. Harris, 1984.

Threats Assessment[3]

Threats have been classified for hairy braya as a whole, insofar as those threats may be relevant to the status of the population in the NWT. The threats assessment is based on whether threats are considered to be of concern for the sustainability of the species over approximately the next 10 years.

This threats assessment was completed collaboratively by members of the NWT Species at Risk Committee, at a meeting on June 15, 2023. The threats assessment will be reviewed and revised as required when the status report is reviewed, in 10 years or at the request of a Management Authority or the Conference of Management Authorities. Parameters used to assess threats are listed in Table 3.

Table 3. Parameters used in threats assessment.

Parameter	Description	Categories
LIKELIHOOD		
Timing (i.e., immediacy)	Indicates if the threat is presently happening, expected in the short term (<10 years), expected in the long term (>10 years), or not expected to happen.	Happening now Short-term future Long-term future Not expected
Probability of event within 10 years	Indicates the likelihood of the threat to occur over the next 10 years.	High Medium Low
CAUSAL CERTAINTY		
Certainty	Indicates the confidence that the threat will have an impact on the population.	High Medium Low
MAGNITUDE		

[3] This approach to threats assessment represents a modification of the International Union for the Conservation of Nature's (IUCN) traditional threats calculator. It was originally modified for use in the Inuvialuit Settlement Region Polar Bear Joint Management Plan (Joint Secretariat 2017). This modified threats assessment approach was adopted as the standard threats assessment method by the Species at Risk Committee and Conference of Management Authorities in 2019.

Extent (scope)	Indicates the spatial extent of the threat (based on percentage of population or area affected)	Widespread (>50%) Localized (<50%)
Severity of population-level effect	Indicates how severe the impact of the threat would be at a population level if it occurred.	High Medium Low Unknown
Temporality	Indicates the frequency with which the threat occurs.	Seasonal Continuous
Overall level of concern	**Indicates the overall threat to the population (considering the above).**	**High** **Medium** **Low**

Overall Level of Concern

The overall level of concern for threats to hairy braya are noted below. Please note that combinations of individual threats could result in cumulative impacts to hairy braya in the NWT. Details be found in the *Detailed Threats Assessment*.

Overall level of concern:

- **Threat 1 – Loss of Habitat - Coastline Erosion** **Low**
- **Threat 2 – Loss of Habitat - Salinization** **Low**
- **Threat 3 – Loss of Habitat - Storm Surges and Flooding** **Low**

Detailed Threats Assessment

Threat #1. Loss of Habitat – Coastline Erosion	
Specific threat	Rapid and increasing rates of coastline erosion have been impacting hairy braya habitat over the past few decades. Significantly reduced ice cover on the Beaufort Sea is contributing to increasing rates of coastal erosion along exposed coastlines. Coastlines of the Beaufort Sea are experiencing some of the highest erosion rates in the Arctic, hastening the elimination of hairy braya habitat along the coast. However, erosion is slower along inlets more protected from ocean waves and inland habitat appears to be stable. Fortunately, most individuals of the species are growing in these more stable habitats.
Stress	The coastlines of Cape Bathurst Peninsula and Baillie Islands are among the most sensitive coastal areas to the impacts of climate change in Canada. Characteristics of these coastlines that are contributing to erosion sensitivity include highly erodible fine sediments, large amounts of permafrost subject to melting and erosion, and an expected increase in sea level and wave height in the region. Coastal areas of Cape Bathurst peninsula and Baillie Islands are eroding rapidly, with large mats of turf, some bearing hairy braya, sliding down steep escarpments toward the sea. Erosion on the coast of Baillie Islands was about 9 m/year, on average, from 1985 to 2021. Erosion on Cape Bathurst peninsula from 1972-2015 ranged from 1.2-1.5 m/year on the shore of Cy Peck Inlet, to 3.7-5.2 m/year on the exposed coast of Cape Bathurst Peninsula, to 2.0-10.9 m/year on the coast of Baillie Islands. Due to warming of the earth's atmosphere, which is expected to continue into the foreseeable future, it is expected that sea levels in the region will increase by 0.2 to 1.0 m over 100 years and protective sea ice will continue to decline, so coastal erosion rates will likely increase.
Extent	Localized (<50%)
Severity	Low
Temporality	Seasonal
Timing	Happening now
Probability	High
Causal certainty	High
Overall level of concern	**Low**

Threat #2. Loss of Habitat – Salinization	
Specific threat	Hairy braya habitat along the coast can be destroyed by salinization where sea spray and storm waves cause an increase in salt content in the soil.
Stress	The relative impact of salinization compared to erosion is not yet well understood. Habitat destruction due to salinization was apparent in 2011, but this was not the case in 2022. Apparently, the effects of salinization can vary over time, perhaps due to a faster rate of erosion than salinization in some years.
Extent	Localized (<50%)
Severity	Low
Temporality	Seasonal
Timing	Long-term future
Probability	Low
Causal certainty	Low
Overall level of concern	**Low**

Threat #3. Loss of Habitat – Storm Surges and Flooding	
Specific threat	Decreases in sea ice over the past few decades have resulted in increases in the duration and severity of storm surges. Hairy braya in low-lying areas may be at risk from possible flooding event due to storm surges.
Stress	Hairy braya is found low-lying areas as well as on top of raised bluffs and uplands. Therefore, although storm surges are an important factor causing coastal erosion, the potential for flooding at low-lying areas is not considered to be a more significant threat to hairy braya than it is elsewhere. Due to warming of the earth's atmosphere, which is expected to continue into the foreseeable future, the probability of storm surges will likely also increase.
Extent	Localized (<50%)
Severity	Low
Temporality	Seasonal

Timing	Happening now
Probability	High
Causal certainty	Low
Overall level of concern	**Low**