Recovery Strategy for the Hairy Braya (*Braya pilosa*) in the Northwest Territories

Species at Risk (NWT) Act
Management Plan and Recovery Strategy Series
2015

WILDLIFE MANAGEMENT ADVISORY COUNCIL (NWT)

Northwest Territories Environment and Natural Resources

For copies of the recovery strategy or for additional information on NWT species at risk, please visit the NWT Species at Risk website (www.nwtspeciesatrisk.ca).

Recommended citation:
Conference of Management Authorities. 2015. Recovery Strategy for the Hairy Braya (*Braya pilosa*) in the Northwest Territories. *Species at Risk (NWT) Act* Management Plan and Recovery Strategy Series. Environment and Natural Resources, Government of the Northwest Territories, Yellowknife, NT. 29 pp.

ISBN: 978-0-7708-0228-8

Cover illustration photo credit: James G. Harris

What is the *Species at Risk (NWT) Act*?

The *Species at Risk (NWT) Act* (the Act) provides a process to identify, protect and recover species at risk in the Northwest Territories (NWT). The Act applies to any wild animal, plant or other species for which the Government of the Northwest Territories (GNWT) has management authority. It applies everywhere in the NWT, on both public and private lands, including private lands owned under a land claims agreement, in accordance with the land claims agreements.

What is the Conference of Management Authorities?

The Conference of Management Authorities (the Conference) was established under the Act and is made up of the wildlife co-management boards and governments in the NWT that share responsibility for the conservation and recovery of species at risk in the NWT (referred to as 'Management Authorities'). The purpose of the Conference is to build consensus among Management Authorities on the conservation of species at risk and to provide direction, coordination and leadership with respect to the assessment, listing, conservation and recovery of species at risk while respecting the roles and responsibilities of Management Authorities under land claim and self-government agreements. The Conference develops consensus agreements on listing species at risk, conservation measures, management strategies and recovery plans. Only Management Authorities that have jurisdiction for that species are involved in making the decisions.

What is a threatened species?

Under the Act, a threatened species is a species that is likely to become endangered in the NWT if nothing is done to reverse the factors leading to its extirpation or extinction.

What is a recovery strategy?

Under the Act, a recovery strategy is a document that recommends objectives for the conservation and recovery of a threatened species. It also recommends approaches to achieve those objectives. It includes a description of threats and positive influences on the species and its habitat. Under the Act, a recovery strategy must be done for threatened species, within two years after the species is added to the NWT List of Species at Risk.

PREFACE

Under the *Species at Risk (NWT) Act*, the Minister of Environment and Natural Resources is ultimately responsible to prepare and complete recovery strategies for listed threatened species. This recovery strategy has been prepared in cooperation with the Management Authorities responsible for the hairy braya: the Government of the Northwest Territories (GNWT) and the Wildlife Management Advisory Council (NWT) (WMAC (NWT)). This recovery strategy also constitutes advice to other jurisdictions and organizations that may be involved in conserving the species.

Success in the conservation and recovery of this species depends on the commitment and cooperation of many different groups that will be involved in implementing the directions set out in this strategy and cannot be achieved by the GNWT, WMAC (NWT) or any other group alone. All NWT residents are invited to join in supporting and implementing this strategy for the benefit of the hairy braya and NWT society as a whole.

This recovery strategy will be followed by a consensus agreement by the Conference of Management Authorities that will lay out the actions Management Authorities agree to undertake to implement it. This recovery strategy does not commit any party to actions or resource expenditures; implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating Management Authorities.

At least every five years, the Conference of Management Authorities will review this recovery strategy and report on the actions undertaken to implement it, and the progress made towards meeting its objectives.

Background information on hairy braya and threats is mainly summarized from the Species at Risk Committee (2012) report. To avoid repetitive citations, it can be assumed that the information was taken from this report, unless another reference is given.

ACCEPTANCE STATEMENT

The Wildlife Management Advisory Council (WMAC (NWT)) and the Government of the Northwest Territories accepted this Recovery Strategy for the Hairy Braya on October 16, 2015.

ACKNOWLEDGMENTS

This document was funded by Environment and Natural Resources (ENR) and the principal compilers of this document were Environment and Natural Resources staff: Lisa Worthington, Species at Risk Recovery Planning Coordinator, and Joanna Wilson, Wildlife Biologist (Species at Risk).

We thank the following organizations and individuals for providing comments that significantly improved the recovery strategy:

Government of Northwest Territories, Environment and Natural Resources

Wildlife Management Advisory Council (NWT)

Environment Canada

Mike Harlow, Chief Land Administrator, Inuvialuit Land Administration (ILA)

James G. Harris, Professor of Biology and Director of Herbarium, Utah Valley University.

EXECUTIVE SUMMARY

The purpose of this recovery strategy is to provide an action-oriented planning tool that identifies how the conservation and recovery of hairy braya (*Braya pilosa*) can be accomplished. It will assist the Management Authorities in deciding what actions to take, how to prioritize their work, and how to allocate their resources. The next step is for Management Authorities to make an agreement laying out the actions they intend to take to implement this strategy. They will review this recovery strategy and report on progress every five years.

This recovery strategy was prepared by the Department of Environment and Natural Resources (ENR) of the GNWT, in accordance with the Conference of Management Authorities' guidelines and template for recovery strategies. There were many steps involved in the process; this included discussions with communities in the Inuvialuit Settlement Region (ISR), conducting Crown consultation with regard to Aboriginal or treaty rights, and providing the opportunity for public comment. Their feedback was incorporated into the plan which was reviewed by all parties involved in managing this species, including GNWT, WMAC (NWT), Inuvialuit Game Council, Environment Canada and Inuvialuit Regional Corporation (IRC).

1. **Species Description and Biology**
   Hairy braya is a perennial plant belonging to the mustard family (Brassicaceae). It is typically 4.5 – 12.0 cm tall. Its stems grow from a tuft of leaves at the base of the plant and have white flowers arranged in dense clusters. It can be distinguished from other *Braya* species by its large flowers and the shape of its fruits (almost round with very long "styles" [elongated reproductive structures]). This plant is endemic to the NWT.

2. **Current status**
   In 2012, hairy braya was assessed by the NWT Species at Risk Committee (SARC) as threatened in the NWT. Hairy braya was subsequently listed as a threatened species under the territorial *Species at Risk (NWT) Act* in 2014. This means hairy braya is likely to become endangered in the NWT if nothing is done to reverse the factors leading to its extirpation or extinction. This recovery strategy is legally required because of the listing of hairy braya in the NWT.

   In 2013, hairy braya was assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). It was assessed as an endangered species in Canada, using criteria with longer timelines for potential extinction than those used by SARC. It is important to note that the different criteria used in SARC and COSEWIC assessments resulted in the different species at risk status between the two committees. As of 2015, hairy braya was under consideration for listing under the federal *Species at Risk Act* (SARA).

3. Population and distribution

Globally, the hairy braya occurs only in the NWT on Inuvialuit private lands. It is found on the northwestern part of Cape Bathurst peninsula and on the nearby Baillie Islands. Hairy braya is restricted to a small area that remained ice-free during the last ice age.

It is estimated that there are about 15,000 to 20,000 hairy braya plants. Along the coast, hairy braya numbers are declining because of rapid coastal erosion and salt spray. Fortunately, most hairy braya plants are found in more stable habitats inland or along protected inlets.

4. Needs and limitations of the hairy braya

Hairy braya appears to be cross-pollinated (pollination takes place between two different flowers). It seems to have very limited ability to expand its range into new areas.

Hairy braya occurs on bluffs and dry uplands along coastlines, inlets and streams. It does not compete well with other plant species, and needs bare soil to become established. Periods of standing water, erosion, and disturbance from caribou hooves appear to be involved in creating or maintaining these bare soil habitats.

5. Threats to survival and recovery

The most obvious threat to hairy braya is habitat loss due to rapid erosion of the coastline. The coastline has been eroding at a rate of about 9 to 10 m per year. The rate of coastal erosion is increasing in the Beaufort Sea due to a reduction in sea-ice; erosion will probably continue increasing as sea level rises due to climate warming. Plants along the coast are also killed by salt spray.

Plants along protected inlets are not as affected by erosion or sea spray but they are vulnerable to random events like storm surges, which could flood low-lying habitat. This is the most serious threat because the bulk of the hairy braya population occurs in low-lying areas that could be affected by flooding.

Human-caused habitat disturbance is currently a minor threat to hairy braya but if human activity were to increase on the Cape Bathurst peninsula, it could become a more significant issue.

6. Conservation and recovery goal

The conservation and recovery goal is to ensure survival of hairy braya in the wild for at least the next 100 years.

7. Conservation and recovery objectives

Objectives for the conservation and recovery of hairy braya are:

1) Secure future existence of hairy braya seeds/plants.
2) Monitor hairy braya population, range and habitat.
3) Obtain information to inform sound management decisions.
4) Minimize detrimental effects of human activities on hairy braya and its habitat.
5) Adaptively co-manage hairy braya in accordance with the best available information.

8. Highlights of the main recommended approaches for conservation and recovery

1) **Secure future existence of hairy braya seeds/plants.**
This approach involves depositing a portion of the existing seed collection for storage and propagation in a seed bank. It also includes gathering samples for the seed bank, from throughout hairy braya's distribution, to cover the range of genetic diversity. Genome sequencing should be conducted and submitted to a gene bank to conserve genetic information.

2) **Monitor hairy braya population, range and habitat.**
Surveying the distribution and abundance of hairy braya every 10 years, or more frequently if possible, will be the focus of this approach. "Possible range" further south on Cape Bathurst Peninsula should be investigated to determine if hairy braya is found there. Storm surges and shoreline erosion (in hairy braya range) should be monitored.

3) **Obtain information to inform sound management decisions.**
This approach includes filling knowledge gaps to inform the management of hairy braya. The possible existence of hairy braya in far eastern Russia should be investigated, and the relationship between hairy braya and other related species should be further studied to establish whether hybridization is a threat. The frequency of storm surges in hairy braya range should be analyzed.

4) **Minimize detrimental effects of human activities on hairy braya and its habitat.**
Hairy braya management authorities should work with the Inuvialuit Land Administration (ILA) to ensure that human impact remains minimal. The intent is to avoid an increase in human-caused habitat disturbance.

5) **Adaptively co-manage hairy braya in accordance with the best available information.**
This approach includes an annual review of information on population, habitat and recovery progress by WMAC (NWT) and GNWT. If necessary, more aggressive recovery actions such as transplantation and habitat modification could be considered.

Table of Contents

1. STRATEGY DEVELOPMENT

1.1 Purpose and Principles

The purpose of this recovery strategy is to provide an action-oriented planning tool that identifies how the conservation and recovery of hairy braya can be accomplished. It will help the Management Authorities decide what actions to take, how to prioritize their work, and how to allocate their resources in order to conserve and recover hairy braya.

The following guiding principles informed the development of this recovery strategy:

- Recognize that the biological diversity of the NWT is a legacy to be preserved, and that all residents have a shared responsibility for the protection and conservation of species at risk;
    - Recognize the shared responsibility of the Management Authorities, seek collaborative partnerships, and expect that all responsible parties will contribute;
    - Involve interested parties in developing the plan/strategy, including engagement at the community level throughout the process, especially for culturally sensitive species;
- Respect treaty and Aboriginal rights, as well as land claim and self-government agreements;
- Recognize that some conservation measures may have social, economic or ecological implications;
- Use Adaptive Management, which is: a systematic approach for continually improving management policies or practices by deliberately learning from the outcomes of management actions;
- Be guided by and implement the Precautionary Principle, which is: where there are threats of serious or irreversible damage, lack of full certainty shall not be used as a reason for postponing cost-effective conservation measures;
- Make full use of the best available information, including traditional, community and scientific knowledge;
    - Recognize and respect differences and similarities in approaches to the collection and analysis of different types of knowledge;
    - Recognize and address information gaps;
- Have a clear goal and clear, measurable objectives;
    - Include only management approaches that are realistic and biologically feasible;
    - Recognize that conservation and recovery can take a long time, therefore long-term approaches are needed.

1.2 Planning Partners

The groups with management authority for hairy braya are WMAC (NWT) and GNWT. The Inuvialuit Regional Corporation (IRC) is a partner in management since it owns the land where hairy braya is found. Government of Canada (Environment Canada) is also involved in management because, if hairy braya becomes listed as endangered under the federal *Species at Risk Act*, Environment Canada would be ultimately responsible for implementing the provisions of the federal *Species at Risk Act* including the identification (to the extent possible) and protection of critical habitat. Management of hairy braya would remain a territorial lead, but Environment Canada would cooperate in implementation as outlined in the *Accord for the Protection of Species at Risk*.

WMAC (NWT) advises governments on wildlife policy, as well as management, regulation and administration of wildlife, habitat and harvesting in the NWT portion of the Inuvialuit Settlement Region (Inuvialuit Final Agreement, section 14). WMAC (NWT) works collaboratively with the Inuvialuit Game Council (IGC), Hunters and Trappers Committees, as well as government, on research, monitoring and management of wildlife and habitat. WMAC (NWT) also consults regularly with the IGC and Hunters and Trappers Committees, and these groups may assist the Council in carrying out its functions.

GNWT, represented by the Minister of Environment and Natural Resources (ENR), has ultimate responsibility for the conservation and management of wildlife, wildlife habitat and forest resources in the NWT, in accordance with land claims and self-government agreements. It is the ultimate responsibility of the Minister of ENR to prepare and complete management plans and recovery strategies under the *Species at Risk (NWT) Act*.

The Inuvialuit Regional Corporation (IRC) is a partner in managing the hairy braya, which occurs only on Inuvialuit private lands. The IRC was formed with the signing of the Inuvialuit Final Agreement (IFA) in 1984 between the Government of Canada and the Inuvialuit people. The IFA became known as the *Western Arctic Claims Settlement Act* and IRC is responsible for managing the affairs of the Settlement, as outlined in the IFA. The goals of the IFA include preserving Inuvialuit cultural identity and values, enabling Inuvialuit people to be equal and meaningful participants in the northern and national economy and society, and protecting and preserving Arctic wildlife, environment and biological productivity. The mandate of IRC is to continually improve the economic, social and cultural well-being of the Inuvialuit people through implementing the IFA.

The Inuvialuit Land Administration (ILA), a division of IRC, is established by the IFA to administer lands allocated to the Inuvialuit under the IFA.

The Government of Canada has ultimate responsibility for the management of migratory birds (as described in the *Migratory Birds Convention Act, 1994*), fish, marine mammals, and other aquatic species (as described in the *Fisheries Act*). It also has responsibilities under the federal *Species at Risk Act*, including the implementation and enforcement of protection for individuals, residences and critical habitat for listed species.

1.3 Planning Process

This recovery strategy was prepared by ENR, following the Conference of Management Authorities' guidelines and template for recovery strategies.

Many sources were considered in the preparation of this strategy, including the following:

- Input from Inuvialuit Regional Corporation (IRC), Inuvialuit Land Administration (a division of IRC), WMAC (NWT), GNWT, Inuvialuit Game Council, Hunters and Trappers Committees, Environment Canada, hairy braya experts and the public;
- NWT Species at Risk Committee's status report, assessment and reasons for assessment of hairy braya, which includes the best available traditional, community and scientific knowledge on hairy braya in the NWT;
    - Species at Risk Committee. 2012. Species Status Report for Hairy Braya (*Braya pilosa*) in the Northwest Territories. Species at Risk Committee, Yellowknife, NT.
- *Species at Risk (NWT) Act*. 2009. S.N.W.T. 2009, c. 16.

As part of the engagement and consultation process, ENR and WMAC (NWT) invited input from the IGC, Hunters and Trappers Committees, ILA, Environment Canada and hairy braya experts. ENR and WMAC (NWT) also visited communities in the Inuvialuit Settlement Region (Inuvik, Sachs Harbour, Ulukhaktok, Aklavik, Paulatuk, and Tuktoyaktuk) in June and July 2014. These meetings provided an opportunity for members of the public and interested organizations to discuss the draft hairy braya recovery framework. The WMAC (NWT) then held public engagement sessions on a final draft of the recovery strategy in Ulukhaktok in June 2015 and Inuvik in July 2015 to review content and discuss potential issues. Review and discussion of the final draft with the IGC and all other HTCs were solicited by letter in the summer of 2015.

ENR consulted with Aboriginal governments and organizations (IGC, IRC and Nunavut Tunngavik Inc.) with respect to potential adverse effects of the recovery strategy on established or asserted Aboriginal or Treaty rights. ENR worked with other GNWT departments through an Inter-departmental Species at Risk Committee and also provided an opportunity for members of the public and interested organizations to comment on the draft recovery strategy in the summer of 2015.

The comments and feedback received through the engagement and consultation process were considered and incorporated, where appropriate, into the hairy braya recovery strategy.

2. SOCIAL PERSPECTIVES

There is no documented traditional or community knowledge on hairy braya, possibly because the species is not culturally or economically important, nor is it harvested by any of the Inuvialuit communities (ENR and WMAC (NWT) 2014). Despite this, the conservation of hairy braya is indeed important because all living things are connected and all species play an important role in maintaining healthy ecosystems. Conservation of hairy braya is essential to conserving biodiversity in the NWT, which contributes overall to the biodiversity of the planet.

Additionally, hairy braya is of considerable interest to scientists because it is very rare and a glacial relict, restricted to an area that remained ice-free during the last ice age.

3. SPECIES INFORMATION

3.1 Species Status

Common Name in English: hairy braya
Name(s) in Other Languages: braya poilu (French)
Scientific Name: *Braya pilosa*
Occurrence:
All known occurrences of hairy braya are in the NWT. There are approximately 13 subpopulations located on the northern portion of Cape Bathurst peninsula and the nearby Baillie Islands, both located in the Inuvialuit Settlement Region.

Assessment by the NWT Species at Risk Committee (SARC): Threatened (December 2012)

SARC Status History: none

Reasons for Designation:

Hairy braya fits criterion (b) for Threatened:

(b) – There is evidence that the range is limited and there is a decline in range, population size and habitat such that it could disappear from the NWT in our children's lifetime

- Range is severely limited (extent of occurrence 250 km^2; index of area of occupancy 64 km^2).
- There are only 5 known locations, but may be more on Cape Bathurst and Baillie Islands.
- Coastal habitat is declining (10 m/year erosion) and this is expected to increase.
- Hairy braya only exists on Cape Bathurst peninsula and Baillie Islands in the NWT, so there is no possibility of rescue from outside populations.
- The ability to expand its range is limited.
- Hairy braya has specialized habitat requirements.
- It does not compete well with other plant species when establishing or colonizing new areas.

Status on NWT List of Species at Risk: Threatened (February 2014)

NWT Listing History: none

NWT General Status Rank: At Risk (2014), May be at Risk (2010)
NWT NatureServe Rank: S2 (2012)
COSEWIC status: Endangered (May 2013)
National NatureServe Rank: N2 (2012)
Federal *Species at Risk Act*: Under consideration for listing as of August 2015
Global NatureServe Rank: G2 (Imperiled) (2012)

3.2 Species Description and Biology

Hairy braya is a plant belonging to the mustard family (Brassicaceae). It is typically 4.5 – 12.0 cm tall. Its stems grow from a tuft of leaves at the base of the plant and have white flowers arranged in dense clusters (Figure 1). It can be distinguished from other *Braya* species by its large flowers and the shape of its fruits (almost round with very long "styles" [elongated reproductive structures]).

Hairy braya is a perennial plant that is considered long-lived (surviving for more than ten years). Its life cycle and reproduction have not been studied, but it appears to be cross-pollinated (pollination takes place between two different flowers). Hybridization may be occurring between hairy braya and smooth braya (*Braya glabella*), and possibly with Greenland braya (*Braya thorild-wulffii*). Genetic sequencing of the ITS region indicates that the closest relative of hairy braya is Greenland braya (J. Harris unpubl. data 2015) and there is good genetic separation between hairy braya and smooth braya (B. Bennett pers. comm. 2015).

Figure 1. Photograph of hairy braya, by James G. Harris, 2004.

3.3 Population and Distribution

Hairy braya occurs only in the NWT, in the Inuvialuit Settlement Region, on Inuvialuit private land as described in the Inuvialuit Final Agreement.

Hairy braya is restricted to a small area on Cape Bathurst Peninsula and the nearby Baillie Islands that remained ice-free during the Pleistocene epoch. The total size of its known range (shown in orange on Figure 2) is approximately 250 km^2. Coastal bluffs and dry uplands in

unglaciated areas on the northwestern side of Cape Bathurst Peninsula and on the Baillie Islands are potential habitat for hairy braya. A large percentage of these habitats were searched for the plant in 2011, but only north of 70.358°N (SARC 2012). The 'possible range' further south (shown in green on Figure 2) was mapped by ENR in February 2014 using satellite imagery. This area appears to contain additional unglaciated, inland dry terrain but has not yet been searched for hairy braya.

There have been unconfirmed reports of hairy braya in Russia (Suzanne Carrière pers. comm. 2010); however, expert examination of possible specimens in Russia remains to be completed. Banks Island has been proposed as a possible site for hairy braya that merits further investigation (J. Harris and B. Bennett pers. comm. 2015), but plant surveys of Aulavik National Park did not record hairy braya (D. S. McLennan pers. comm. 2015). Other collections of *Braya* from Banks Island did not include the species either (SARC 2012).

The Species at Risk Committee (SARC) defined 13 known subpopulations of hairy braya. Within these subpopulations it is estimated that there are 15,000 to 20,000 plants, with approximately 80% being mature.

One coastal subpopulation of hairy braya experienced a drastic decline between 2004 and 2011 because of habitat erosion. Other subpopulations on eroding shorelines are expected to decline as well. Population trends for subpopulations on protected sections of the coast and on inland bluffs have not been determined, but they appeared to be stable when examined in summer 2011.

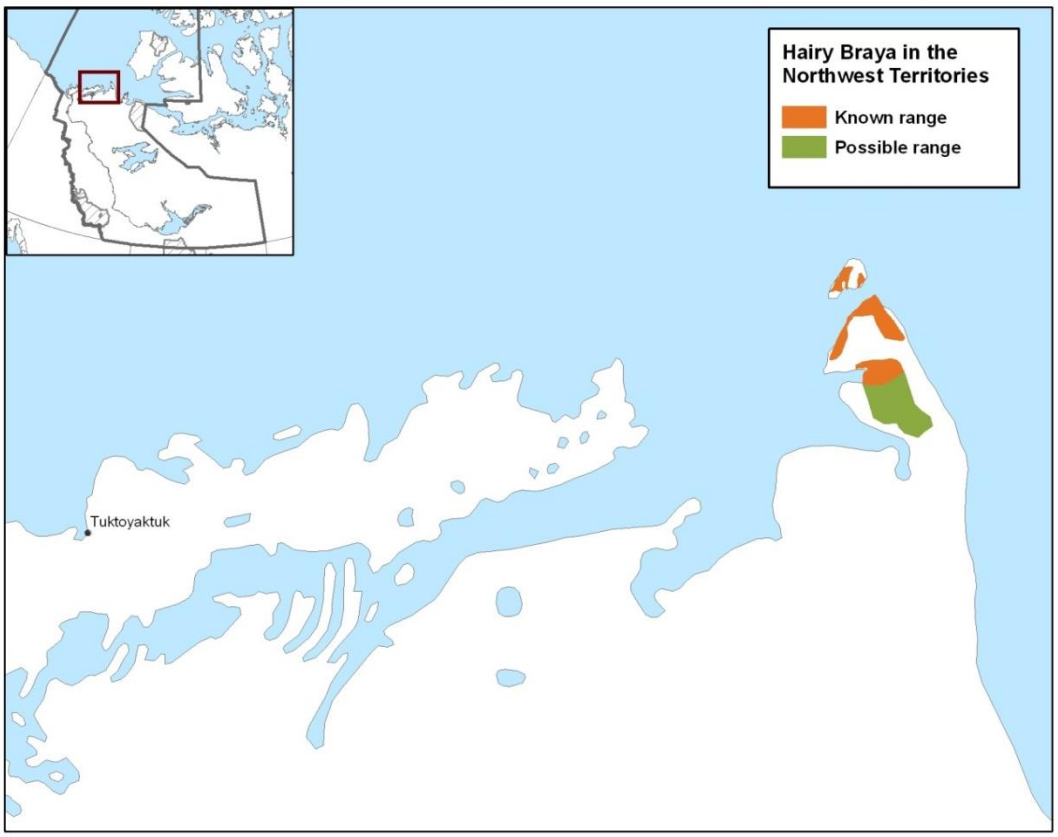

Figure 2. Approximate known range and possible range of the hairy braya.

Map created by ENR, February 2014.

3.4 Needs and limitations of the hairy braya

Hairy braya can be found on coastal bluffs and dry uplands composed of calcareous sandy loam and silty clay loam soils. The plant communities in which it is found are dominated by Arctic willow (*Salix arctica*), entire-leaved mountain-avens (*Dryas integrifolia*), and various grass species.

Hairy braya seems to be a poor competitor and require bare soils for seedling establishment. It appears that erosion of coastal bluffs and disturbance from caribou hooves are at least partially responsible for creating this bare soil habitat. However, creation of bare soil habitat is most commonly the result of seasonal periods of standing water that eliminate most other plant species from small depressions in otherwise dry habitats.

There are limited areas of bare soil habitat available on the Cape Bathurst peninsula. Patches of suitable habitat for hairy braya are often separated from one another by large areas of wet tundra, eroded habitat, or habitat impacted by salt spray. Hairy braya habitat along the northwest facing coast is eroding quickly and is also impacted by salt spray.

The life history and ecology of hairy braya have been little studied, but some reasonable assumptions can be made with regard to factors that limit the distribution and abundance of the species. The extremely limited distribution of hairy braya strongly suggests that it has little ability to expand its range and move onto seemingly appropriate habitat in surrounding areas. This is probably due to the fact that hairy braya is likely cross-pollinated, meaning that multiple plants are required to reproduce, therefore the establishment of a single individual in a new area cannot lead to a new population. Two rare seed dispersal events are required to establish a new population of a cross-pollinated species. Hairy braya may also require stable habitats over long periods of time (i.e. longer than the 15,000 years that have elapsed since the last glacial maximum) to establish and maintain viable populations.

3.5 Threats

The main threats to hairy braya are potential flooding (in low-lying areas) as well as coastal erosion and salt spray (along the northwest-facing coast). Introduction of genetic material through hybridization is a possible threat but the impact is currently unknown. Human activities presently have no significant impact on hairy braya.

The hairy braya appears to lack the ability to expand its distribution range; therefore, it is particularly susceptible to threats.

Potential flooding
Hairy braya in low-lying areas could be susceptible to flooding from storm surges. The frequency of storm surges is not known, but is expected to increase due to loss of sea ice and the subsequent rise in sea level. It is reasonable to expect that a storm surge could happen in the short term (Vermaire *et al.* 2013). A storm surge that floods low-lying habitat could be disastrous

for the hairy braya since about half to two-thirds of all hairy braya plants are found in low-lying coastal areas, including the largest subpopulation of over 10,000 plants. Flooding would likely kill all affected plants. The potential for flooding is likely the most serious threat to hairy braya.

Shoreline erosion and salt spray
Shoreline erosion and salt spray, leading to habitat loss and plant mortality, are significant threats to hairy braya subpopulations along the northwest coast of the Cape Bathurst peninsula and Baillie Islands. Approximately 1 or 2% of the hairy braya population could be affected by erosion and salt spray over the next 10 years.

Recent estimates of the rate of erosion for some parts of the Cape Bathurst peninsula, based on high-resolution satellite imagery, are 9 to 10 m per year over the past 38 years. The rate of coastal erosion is increasing due to reduced ice cover on the Beaufort Sea over recent decades. With the warming of the earth's atmosphere and reduction of sea ice, sea levels in the region are expected to increase by 0.2 to 1.0 m over 100 years. As sea ice declines further, coastal erosion rates will continue to increase.

Salt spray along the coast also leads to hairy braya habitat loss and plant mortality, possibly at a faster rate than erosion itself. This threat is already happening and likely kills all affected plants.

Hybridization
Smooth braya is a widespread species that is sometimes found growing close to hairy braya. Greenland braya is a closely related species that is found in the northern Arctic islands, as close as southern Banks Island. Hybridization may be occurring between hairy braya and these other species, but there is currently not enough information to determine this with certainty. Whether hybridization would have a negative influence on hairy braya is also unknown at this point. In some cases, hybridization can lead to "genetic swamping" (the assimilation of one species by another species).

Human impacts on habitat
Human activity in the hairy braya range is very limited due to its remote location. For example, the area is frequented occasionally by polar bear hunters in the winter and spring via snowmobile. The impact of this activity on hairy braya habitat is unknown but probably minor. Human-caused habitat disturbance needs to be managed in the future to avoid this minor threat becoming a more significant issue for hairy braya. Human disturbance is one of the only threats to hairy braya that can be directly managed.

3.6 Factors that may have a positive influence

Due to the remoteness of the Cape Bathurst peninsula, there is minimal direct impact resulting from human activities. Inuvialuit have little to no interest in harvesting the plant, so there is no threat of overharvesting (ENR and WMAC (NWT) 2014).

The area where hairy braya is found overlaps with the calving ground of the Cape Bathurst barren-ground caribou subpopulation. The Tuktoyaktuk Community Conservation plan states

that the area includes resources of particular significance and sensitivity throughout the year and recommends that it "be managed so as to eliminate, to the greatest extent possible, potential damage and disruption" (TCCP 2008).

Other positive influences result from the process used by the ILA who issue permits for development projects on Inuvialuit-owned lands. The ILA consults with a wide range of stakeholders, including affected Hunters and Trappers Committees, on all land use applications and can issue permits with associated terms and conditions. These conditions could include provisions for specific protection of hairy braya.

Exploration and development cannot currently take place in the hairy braya range since Section 7(1)aii of the *Inuvialuit Final Agreement* includes a moratorium on these activities in the Cape Bathurst area (Annex D of the agreement).

3.7 Knowledge Gaps

The possible existence of hairy braya in Russia has been reported, but it has not been confirmed. Investigating this report would contribute to the current knowledge and conservation of this plant.

There is a possibility of hybridization between hairy braya, smooth braya and Greenland braya. A thorough genetic analysis of the three plants is required before the relationship between them can be determined. This would include plant breeding studies (e.g., attempting to cross hairy braya with Greenland braya and smooth braya) and genetic sequencing of other gene regions (since only the ITS region has been sequenced so far). Research like this would help to establish whether hybridization is a threat to hairy braya.

The frequency and strength of storm surges in hairy braya range are not known. More knowledge about storm surges would help management authorities better understand the threats to hairy braya.

4. CONSERVATION AND RECOVERY

4.1 Conservation and Recovery Goal

The conservation and recovery goal is to ensure survival of hairy braya (*Braya pilosa*) in the wild for at least the next 100 years.

Since hairy braya habitat is changing rapidly (i.e. erosion of the Cape Bathurst peninsula and Baillie Islands) and at least some of these changes are beyond our control, it may not be feasible to maintain hairy braya throughout its entire historic range forever. Survival (i.e., the continued existence of some hairy braya plants) in the wild over at least the next 100 years is believed to be an achievable target.

4.2 Conservation and Recovery Objectives

This recovery strategy recommends the following objectives for the conservation and recovery of the hairy braya:

Table 1. Conservation and Recovery Objectives

No.	Conservation and Recovery Objective
1	Secure future existence of hairy braya seeds/plants.
2	Monitor hairy braya population, range and habitat.
3	Obtain information to inform sound management decisions.
4	Minimize detrimental effects of human activities on hairy braya and its habitat.
5	Adaptively co-manage hairy braya in accordance with the best available information.

4.3 Approaches to Achieve Objectives

This recovery strategy recommends approaches to achieve the conservation and recovery objectives for the hairy braya. The recommended approaches are described below and summarized in Table 2.

Objective #1: Secure future existence of hairy braya seeds/plants.
The focus of Objective #1 is to ensure that some hairy braya seeds and/or plants are secured in a safe location for the future. This would allow for possible breeding and re-introduction of hairy braya in case it is ever needed (e.g., if there is ever a sudden population crash or major loss of habitat).

Approach 1.1: Deposit a portion of the existing seed collection for storage and propagation in a seed bank.
There is already an existing seed collection for hairy braya at Utah Valley University. Depositing some of these seeds in a secure seed bank would ensure they are safely stored, propagated and kept viable for the future.

Approach 1.2: Gather samples from throughout the hairy braya's distribution for seed bank, to cover the range of genetic diversity.
Ideally, seeds from across the hairy braya's range should be stored so the full range of genetic diversity is represented. Collecting additional hairy braya seeds from throughout the range could be done as part of any future field work on Cape Bathurst peninsula, with the appropriate permits.

Approach 1.3: Conduct genome sequencing for hairy braya and submit to gene bank to conserve genetic information.
Sequencing hairy braya DNA would ensure that genetic information survives even though the plant itself faces an uncertain future. Genome sequencing is now relatively inexpensive, and could easily be completed using a small sample from the existing seed collection. Submitting the genetic information to a gene bank would ensure it is curated and remains available in the long term.

Objective #2: Monitor hairy braya population, range and habitat.
Objective #2 focuses on monitoring the condition of hairy braya population and habitat so that appropriate management decisions can be made. If the situation for hairy braya worsens (e.g., an extensive increase in habitat erosion, or a significant die-off due to a storm surge), managers need to be kept informed so they can consider a more aggressive recovery action.

Approach 2.1: Survey the distribution and abundance of hairy braya every 10 years, and investigate *possible range* further south on the Cape Bathurst peninsula to determine if hairy braya is found there.
The first survey of hairy braya was completed in 2011. Conducting a similar survey periodically (e.g., every 10 years) would allow managers to examine the condition of the species and its range. Since the habitat is eroding rapidly, surveying more frequently (if possible) would better capture changes in habitat condition. One section further south on Cape Bathurst Peninsula might be *possible range* for hairy braya, but has not yet been surveyed. Any future survey should investigate this area to determine whether it is part of the range.

Approach 2.2: Monitor shoreline erosion in hairy braya range using satellite imagery.
The past rate of erosion of coastal hairy braya habitat was estimated by comparing satellite images of the shoreline from 1972 to 2010. Repeating this analysis periodically with new images would provide current information on erosion rates so managers can observe changes in hairy braya habitat. There may be an opportunity to collaborate with the ILA on shoreline erosion studies that can inform their Shoreline Management Plan.

Approach 2.3: Monitor storm surges in hairy braya range.
Keeping track of storm surges is important because most hairy braya plants occur in low-lying coastal areas that could easily be flooded if there is a major storm surge. Monitoring storm surges would give managers a warning sign for a possible die-off of hairy braya.

Objective #3: Obtain information to inform sound management decisions.
Objective #3 is about filling information gaps so that hairy braya management can be based on the best possible information. There are some research questions that are worth exploring, possibly through partnerships with academic researchers or other agencies.

Approach 3.1: Investigate the reported possible existence of hairy braya in Russia.
Although the bulk of knowledge indicates that hairy braya only occurs in the NWT, there has been an unconfirmed report of hairy braya in Russia. The Russian plant specimens should be examined by an expert to determine if they are indeed hairy braya.

Approach 3.2: Study the relationship between hairy braya and other related species (smooth braya and Greenland braya) to better understand whether hybridization is a threat.
Hybridization between hairy braya and other species that occur nearby has been identified as a possible threat, but there is not enough information to know whether it is in fact occurring. Studying the genetic relationship between hairy braya and other related species (smooth braya and Greenland braya) would help to determine whether hybridization is a threat.

Approach 3.3: Analyze the frequency of storm surges in hairy braya range.
Storm surges that could flood low-lying habitat are a concern for hairy braya, but the likelihood of such a storm surge is unknown. Ocean and climate specialists may have information that could be analyzed to predict the likelihood of a storm surge impacting the Cape Bathurst peninsula.

Objective #4: Minimize detrimental effects of human activities on hairy braya and its habitat.
The aim of Objective #4 is to ensure that human activities do not accidentally kill hairy braya plants or destroy their habitat. Human impact is currently minimal in the hairy braya range, but if this changes in the future, it could pose a threat to this plant.

Approach 4.1: Work with the Inuvialuit Land Administration (ILA) to ensure that human impacts remain minimal; i.e. avoid any increase in human-caused habitat disturbance.
Hairy braya occurs on Inuvialuit private land and the Inuvialuit Final Agreement grants the ILA sole responsibility to manage the land. The ILA screens development proposals and can attach conditions to projects to ensure that land and resources are not harmed. The ILA also 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. Hairy braya can be protected from human disturbance by working with the ILA to ensure that potential human impacts on hairy braya are avoided or minimized.

Approach 4.2: Work with local Hunters and Trappers Committees and Inuvialuit Game Council to educate about hairy braya and the importance of minimizing human impacts.

Inuvialuit people play an important role in the recovery of the hairy braya. Continued exchange of information with Inuvialuit can help raise awareness of the species and build and maintain support for its conservation.

Objective #5: Adaptively co-manage hairy braya in accordance with the best available information.

The focus of Objective #5 is to have managers periodically review the latest information on the state of hairy braya and review the progress on hairy braya recovery. Regular check-ins would help ensure that the recovery strategy is used and that hairy braya management actions are adjusted if needed.

Approach 5.1: WMAC (NWT) and GNWT to annually review progress on recovery actions, as well as current information on population and habitat.

WMAC (NWT) and the GNWT should review hairy braya information and current threats to hairy braya (e.g., storm surges, coastal changes, human activities) together every year at regularly scheduled meetings. They should review any new information on the status of the hairy braya population and habitat, discuss progress on the actions under this recovery strategy, and discuss whether current management is still appropriate.

Approach 5.2: If necessary, consider more aggressive recovery actions such as transplantation and habitat modification.

If the situation for hairy braya worsens (e.g., if there is a severe population or habitat decline), the GNWT and WMAC (NWT) could consider more aggressive recovery actions such as transplantation, habitat modification, or the construction of greenhouses on the tundra to plant hairy braya (similar to International Tundra Experiment sites).

Table 2. Recommended approaches to achieve conservation and recovery objectives for hairy braya in NWT

Relative priority can be Critical, Necessary or Beneficial. *Critical* approaches are the highest priority for survival and/or recovery and should be implemented sooner rather than later. *Necessary* approaches are important to implement for survival and recovery but with less urgency than Critical. *Beneficial* approaches help to achieve recovery goals but are less important to the survival and recovery of the species compared to Critical or Necessary.

Relative timeframe can be short-term, long-term, or ongoing. *Short-term* approaches should be completed within five years and *long-term* approaches require more than five years to complete. *Ongoing* approaches are long-term actions carried out repeatedly on a systematic basis.

Relative Priority	Relative Time-frame	Category	Threats or Knowledge Gaps Addressed	Approach to Conservation and Recovery
Objective #1: Secure future existence of hairy braya seeds/plants.				
Critical	*Short-term*	- Protection of species	– All threats	1.1 Deposit a portion of the existing seed collection for storage and propagation in a seed bank.
Necessary	*Long-term*	- Protection of species	– All threats	1.2 Gather samples from throughout the hairy braya's distribution for seed bank, to cover the range of genetic diversity.
Beneficial	*Short-term*	- Protection of species	– All threats	1.3 Conduct genome sequencing for hairy braya and submit to gene bank to conserve genetic information.

Relative Priority	Relative Time-frame	Category	Threats or Knowledge Gaps Addressed	Approach to Conservation and Recovery
Objective #2: Monitor hairy braya population, range and habitat.				
Necessary	*Ongoing*	- Monitoring of species and habitat	– Monitoring species, habitat and threats	2.1 Survey the distribution and abundance of hairy braya every 10 years, and investigate *possible range* further south on the Cape Bathurst peninsula to determine if hairy braya is found there.
Necessary	*Ongoing*	- Monitoring of habitat and threats	– Habitat shifting and alteration (erosion & salt spray)	2.2 Monitor shoreline erosion in hairy braya range using satellite imagery.
Necessary	*Ongoing*	- Monitoring of habitat and threats	– Storms and flooding (storm surges flooding low-lying areas)	2.3 Monitor storm surges in hairy braya range.
Objective #3: Obtain information to inform sound management decisions.				
Beneficial	*Short-term*	- Research on species and habitat	*Knowledge gap:* – Possible existence of hairy braya in Russia has been reported, but not confirmed.	3.1 Investigate the reported possible existence of hairy braya in Russia.
Beneficial	*Long-term*	- Research on species and habitat	*Knowledge gap:* – Is hybridization a threat? A genetic analysis of the three plant species is required to determine this.	3.2 Study the relationship between hairy braya and other related species (smooth braya and Greenland braya) to better understand whether hybridization is a threat.

Relative Priority	Relative Time-frame	Category	Threats or Knowledge Gaps Addressed	Approach to Conservation and Recovery
Necessary	*Long-Term*	- Research on threats	*Knowledge gap:* – Likelihood of a storm surge in hairy braya range	3.3 Analyze the frequency of storm surges in hairy braya range.
Objective #4: Minimize detrimental effects of human activities on hairy braya and its habitat.				
Critical	*Short-term and Ongoing*	- Stewardship - Protection of species and habitat	– Work and other activities (human intrusion and disturbance)	4.1 Work with the Inuvialuit Land Administration to ensure that human impacts remain minimal; i.e., avoid any increase in human-caused habitat disturbance.
Necessary	*Ongoing*	- Communications, Education & Outreach - Stewardship - Protection of species and habitat	– Human impacts on habitat	4.2 Work with local Hunters and Trappers Committees and Inuvialuit Game Council to educate about hairy braya and the importance of minimizing human impacts.
Objective #5: Adaptively co-manage hairy braya in accordance with the best available information.				
Critical	*Ongoing*	- Management of species and habitat	– All threats	5.1 WMAC (NWT) and GNWT to annually review progress on recovery actions, as well as current information on population and habitat.
Critical	*Long-term*	- Management of species and habitat	– All threats	5.2 If necessary, consider more aggressive recovery actions such as transplantation or habitat modification.

4.4 Socioeconomic and Environmental Effects of Management

Excessive collection of hairy braya or its seeds could be detrimental to the survival of the species. If hairy braya plants or seeds are collected (as suggested under Objective #1), care should be taken so the number of plants impacted is small relative to total population size.

Objective #4 (to minimize detrimental effects of human activities on hairy braya and its habitat) reinforces community conservation priorities that are already in place. The Tuktoyaktuk Community Conservation Plan already recommends that the Cape Bathurst peninsula "be managed so as to eliminate, to the greatest extent possible, potential damage and disruption" (TCCP 2008) and there is already a moratorium on exploration and development in the Cape Bathurst area under the *Inuvialuit Final Agreement*.

The recommended conservation and recovery approaches are not expected to have significant impacts on other species.

4.5 Measuring Progress

Performance Measure	Indicators to be monitored
Goal: Ensure survival of hairy braya in the wild for at least the next 100 years.	
Status of hairy braya Status of hairy braya has not become further at risk (i.e. not endangered) when reassessed by the NWT Species at Risk Committee (SARC). **Population and habitat trends** Rate of habitat loss has not significantly increased Population trends are stable or increasing	- Status of hairy braya in NWT as assessed by SARC every 10 years - Estimated rate of habitat loss due to coastline erosion and storm surges - Estimated number of individuals in population
Objective #1: Secure the future existence of hairy braya seeds/plants.	
Seed bank Seeds are collected and deposited in a secure seed bank. **Gene bank** Genome is sequenced and submitted to gene bank.	- Number of seeds deposited in seed bank - Extent of range sampled for seed bank - Extent of genome sequenced and submitted

Performance Measure	Indicators to be monitored
Objective #2: Monitor hairy braya population, range and habitat.	
Monitoring Survey occurs every 10 years. Possible range is investigated. Shoreline erosion rates are monitored. Occurrence of storm surges is monitored.	- Length of time between population surveys - Extent of *possible range* that has been surveyed - Frequency of estimates for erosion rates - Frequency of information on storm surges
Objective #3: Obtain information to inform sound management decisions.	
Information collected and shared Research reports, maps and other information products are produced and shared with decision-makers and communities.	- Number of reports or other information products completed and shared
Objective #4: Minimize detrimental effects of human activities on hairy braya and its habitat.	
Work with ILA on habitat management Agreement with ILA on habitat management **Work with IGC and HTCs on education** There is an increase in awareness of hairy braya and the importance of minimizing human impacts.	- Agreement reached - Agreement being implemented - Agreement reviewed - Number of meetings or workshops (possibly including number of people in attendance) in which information about hairy braya is shared.
Objective #5: Adaptively co-manage hairy braya in accordance with the best available information.	
Co-management systems functioning - Co-management bodies annually review information and progress on hairy braya recovery. - Co-management bodies make management recommendations in response to changes in hairy braya numbers or range.	- A summary review using indicators described in this table is provided to the co-management bodies on an annual basis.

5. NEXT STEPS

This recovery strategy will be followed by a consensus agreement by the Conference of Management Authorities that will lay out the actions Management Authorities agree to undertake to implement it. This recovery strategy does not commit any party to actions or resource expenditures; implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating Management Authorities.

At least every five years, the Conference of Management Authorities will review this recovery strategy and report on the actions undertaken to implement it, and the progress made towards meeting its objectives. The first progress report will be due in 2021. The recovery strategy may also be updated at that time.

6. REFERENCES

Environment and Natural Resources (ENR) and Wildlife Management Advisory Council (NWT) (WMAC (NWT)). 2014. Notes from public community meetings in Aklavik, Paulatuk, Inuvik, Tuktoyaktuk, Ulukhaktuk, Sachs Harbour (June to July 2014). GNWT, Yellowknife, Northwest Territories, 20 pp.

Harris, J.G. 1985. A revision of the genus *Braya* (Cruciferae) in North America. Unpublished Ph.D. thesis, University of Alberta, Edmonton, AB.

Species at Risk Committee. 2012. Species Status Report for Hairy Braya (*Braya pilosa*) in the Northwest Territories. Species at Risk Committee, Yellowknife, NT. 35 pp.

Species at Risk (NWT) Act. 2009. S.N.W.T. 2009, c. 16.

Tuktoyaktuk Community Conservation Plan (TCCP). 2008. A plan for the conservation and management of natural resources and lands within the Inuvialuit Settlement Region in the vicinity of Tuktoyaktuk, Northwest Territories. Prepared by the Community of Tuktoyaktuk, Wildlife Management Advisory Council (NWT), and Joint Secretariat.

Vermaire, J. C., M. F. J. Pisaric, J. R. Thienpont, C. J. Courtney Mustaphi, S. V. Kokelj, and J. P. Smol. 2013. Arctic climate warming and sea ice declines lead to increased storm surge activity. Geophysical Research Letters 40: 1386–1390. doi:10.1002/grl.50191.

Western Arctic. (Inuvialuit) Claims Settlement Act. 1984. c. 49

Background information on hairy braya and threats is mainly summarized from the *Species at Risk Committee (2012)* report. To avoid repetitive citations, it can be assumed that the information was taken from this report, unless another reference is given.

Personal communications cited:

Bruce Bennett, Coordinator, Yukon Conservation Data Centre, Environment Yukon, Whitehorse, YT.

Suzanne Carrière, Wildife Biologist (Biodiversity). Wildlife Division Environment and Natural Resources, Yellowknife, NT.

James G. Harris, Professor of Biology and Director of Herbarium, Utah Valley University, Utah, USA.

Donald S. McLennan, Head – Monitoring Science, Canadian High Arctic Research Station, Hull, QC.