Species at Risk Act
Management Plan Series

Management Plan for the Nahanni Aster (*Symphyotrichum nahanniense*) in Canada

Nahanni Aster

2021

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Canada

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For copies of the management plan, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

Cover illustration: Nahanni Aster. Parks Canada, August 2019.

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[1] www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of management plans for listed species of special concern and are required to report on progress within five years after the publication of the final document on the SAR Public Registry.

The Minister of Environment and Climate Change and Minister responsible for the Parks Canada Agency is the competent minister under SARA for the Nahanni Aster and has prepared this management plan, as per section 65 of SARA. Environment and Climate Change Canada and the Government of the Northwest Territories reviewed and commented on management plan drafts. The following Indigenous communities were invited to provide feedback: Acho Dene Koe First Nation, Dehcho First Nations, Fort Simpson Métis Council, Liard River First Nation, Líídlı̨ı̨ Kų́ę́ First Nation, Nahʔą Dehé Dene Band, and Ross River Dena Council. The Nahʔą Dehé Consensus Team, Nahanni National Park Reserve's cooperative management board, also had the opportunity to review and comment on the plan.

Success in the conservation of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this plan and will not be achieved by the Parks Canada Agency, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this plan for the benefit of the Nahanni Aster and Canadian society as a whole.

Implementation of this management plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

[2] www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2

Acknowledgments

This management plan was prepared by Sarah Arnold, Michelle Sawatzky, Danielle Thompson and Kathryn Walpole (Parks Canada). The information in this plan is largely based on the Nahanni Aster COSEWIC Assessment and Status Report (COSEWIC 2014), the Species Status Report for Nahanni Aster in the Northwest Territories (Harris *et al*. 2014), and 2019 survey results (Parks Canada 2019). Additional comments and assistance in developing the management plan were provided by the Nahʔą Dehé Consensus Team, Gary Allen, Kim Borg, Diane Casimir, Leah de Forest, Katriina O'Kane, and Jonathan Tsetso (Parks Canada).

Executive Summary

Nahanni Aster (*Symphyotrichum nahanniense*) is a small, perennial wildflower that is endemic to Canada. It grows to a height of up to 35 cm in clumps of two to ten stems from short, woody rhizomes. Plants generally have one to three floral heads, although some plants have 15 or more. Each floral head consists of yellow disk flowers surrounded by 15 to 41 white to pale pink ray flowers.

There are only seven known subpopulations of Nahanni Aster, all of which occur within 150 km of one another in Nahanni National Park Reserve in the southern Mackenzie Mountains of the Northwest Territories. Nahanni Aster grows around the edges, seepages and streams of thermal springs with tufa (calcium carbonate deposits). It is usually rooted in moss, but it has also been found in broken old tufa and dense turf with rushes and sedges. Nahanni Aster grows in open areas, unshaded by shrubs or trees. Little is known about Nahanni Aster biology, habitat requirements, or ecological interactions.

Nahanni Aster was assessed as Special Concern by COSEWIC in 2014 and is currently listed as Special Concern on Schedule 1 of the *Species at Risk Act* (SARA).

Nahanni Aster is found entirely in a very remote, protected area and as a result, there are few known threats to the species. Possible threats to Nahanni Aster are all considered negligible and speculative, but may include alteration to groundwater discharge due to climate change or geologic seismic activity, landslides, human activity at the sites, and potential invasive species range expansions into the region. Rather than external threats, Nahanni Aster's small population and restricted distribution are considered the greatest limiting factors to its continued existence.

The objective of this management plan is thus to continue to protect and maintain the distribution and abundance of the Nahanni Aster population, while improving our understanding of the species ecological role and requirements, and promoting awareness of the species, possible threats, and research opportunities.

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1. COSEWIC* Species Assessment Information

Date of Assessment: May 2014

Common Name (population): Nahanni Aster

Scientific Name: *Symphyotrichum nahanniense*

COSEWIC Status: Special Concern

Reason for Designation: The global population of this species is restricted to six hot springs in Nahanni National Park Reserve. A very small range and population size make this endemic species susceptible to losses through natural alterations due to geothermal processes or to landslide events that may become more frequent as climate warms and permafrost melts.

Canadian Occurrence: Northwest Territories

COSEWIC Status History: Designated Special Concern in May 2014

* COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

NOTE: Section 1 is copied verbatim from COSEWIC (2014), and describes six springs where Nahanni Aster is found. A seventh site was discovered in 2019, after this assessment. The rest of this management plan discusses all seven known sites.

2. Species Status Information

Nahanni Aster was listed as Special Concern on Schedule 1 of the *Species at Risk Act* (S.C. 2002, c.29) (SARA) on February 2, 2018. The species has not been assessed under the *Species at Risk (Northwest Territories) Act* (S.N.W.T. 2009, c.16)

The species is globally ranked G3 (Vulnerable), nationally ranked N3 (Vulnerable) in Canada, and sub-nationally ranked S3 (Vulnerable) in the Northwest Territories (Table 1).

Table 1: List and description of various conservation status ranks for Nahanni Aster (NatureServe 2018)

	Global (G) Rank	National (N) Rank	Sub-national (S) Rank	COSEWIC Status	SARA Status
Nahanni Aster (*Symphyotrichum nahanniense*)	G3 (Vulnerable)	Canada - N3 (Vulnerable)	Northwest Territories - S3 (Vulnerable)	Special Concern	Special Concern[3]

[3] Special Concern (SARA): Species which may become threatened or endangered because of a combination of biological characteristics and identified threats

3. Species Information

3.1. Species Description

Nahanni Aster is a wildflower that grows up to 35 cm tall with white to pale pink flower heads (Scotter & Cody 1974). It usually grows in clumps of two to ten stems from short, woody rhizomes. The green to reddish stems are branched, forming an open panicle (a loosely branched cluster of flowers), and are often covered in fine woolly hairs (Owen *et al*. 2006). The stem leaves are linear (long and narrow maintaining the same width along the entire length) to linear-lanceolate (long and narrow, but slightly wider at the middle), about 6.5 cm long, lack a stalk and are slightly clasping at the base (Owen *et al*. 2006). Individual plants tend to have one to three floral heads (Owen *et al*. 2006), but plants with more than 15 floral heads have been observed (Harris & Foster 2012). Each floral head is 2 cm or more in diameter and consists of yellow disk florets, surrounded by 15-41 white to pale pink rays, which are about 1.5 cm long (Owen *et al*. 2006).

Biology

Nahanni Aster is a perennial species that reproduces both sexually and asexually. Flowering occurs from August to September (peaking in mid to late August), with pollination presumed to be by bees and other insects, like other aster species. Seed production is estimated at up to several hundred seeds per stem, if each of the 1 to 15 flowering heads contains 20 to 60 disk florets (Brouillet *et al.* 2006). Nothing is known, however, about seed dormancy, germination or maturation. Nahanni Aster is also known to regenerate clonally from rhizomes, which makes counting individual plants difficult.

Distance to and scarcity of suitable habitat likely limits Nahanni Aster dispersal via wind-borne seeds. Of the seven known subpopulations, the chance of dispersal is higher between the four closest sites along the Flat River (86-030, Old Pots, Thirteen Steps, and Wildmint) than between the more isolated sites of Gahnįhthah (Rabbitkettle), Persistent, or Sibbeston (Harris *et al*. 2014). Other springs with tufa, but without Nahanni Aster subpopulations, are known to the north, west, and east of the Nahanni Aster sites (Figure 2; see also Figure 1 in Harris & Foster 2012), but the amount of habitat is small (probably less than 1 km^2 distributed across more than 25,000 km^2) and the sites are at least 60 km from known subpopulations, so the probability of dispersal is low.

Ecological Role

Very little is known about the role of Nahanni Aster in ecosystem processes, but its ecological role is likely limited given the species restricted distribution and small population. Incidental observations of pollinators visiting Nahanni Aster flowers during the 2012 surveys included butterflies (Northwestern Fritillary (*Speyeria hesperis*), sulphurs (*Colias* spp.), and Dorcas Copper (*Lycaena dorcas*)), bumblebees (*Bombus*

spp.), and diurnal moths (Lepidoptera). However, no herbivory or insect egg-laying was noticed during the 2012 or 2019 surveys (Harris *et al.* 2014; Parks Canada 2019).

3.2. Species Population and Distribution

The Nahanni Aster was first documented at three thermal springs (Gahnı̨hthah (Rabbitkettle), Old Pots, and Wildmint) in Nahanni National Park Reserve following general botanical surveys in the 1960s and 1970s (Scotter & Cody 1974).

Dr. John C. Semple of the University of Waterloo completed the first dedicated Nahanni Aster survey in August 2003 in cooperation with Parks Canada staff. Two observers spent 0.5 to 3.5 hours looking for the plant around open areas at nine thermal springs. Nahanni Aster was confirmed at the three known sites, discovered at one location (Thirteen Steps), and not observed at five springs. Where Nahanni Aster occurred, observers visually estimated the number of mature stems present and collected samples to verify species identification and conduct germination experiments.

Robert Foster and Allan Harris of Northern Bioscience and Douglas Tate from Parks Canada completed a more extensive survey in 2012 in preparation for a planned Northwest Territories Species at Risk Committee review that ultimately didn't happen (Harris *et al*. 2014). Fifty thermal springs, known from prior geological research (Caron *et al*., 2008) but not surveyed in previous botanical work (e.g. Line 2001), were flown over by helicopter to assess habitat potential. Thorough ground searches for Nahanni Aster, lasting between one to three person-hours, were conducted at 24 sites where there was open habitat with tufa, or where pale flowers were visible from the air. Surveyors visually estimated the number of flowering stems and the area of occupied habitat. The species was confirmed at all four known sites and discovered at a fifth and sixth site, 086-30 and Sibbeston Springs (Harris & Foster 2012).

The most recent survey was in 2019 when four Parks Canada staff surveyed all six known sites. Staff also visited three additional springs that were unable to be surveyed in 2012 but which had water quality characteristics similar to the known sites (Caron *et al*., 2008), indicating potential Nahanni Aster habitat. A seventh Nahanni Aster subpopulation was found at Persistent Spring, and staff initiated a more repeatable method of estimating species abundance and understanding the distribution and variation in suitable growing conditions for the species at all seven known sites (Parks Canada 2019). Subpopulation extents were mapped using GPS and stem counts conducted at three to four 1 m^2 grid plots placed randomly across each site to estimate overall abundance.

There are approximately 150 known springs (Figures 1 and 2) in the southern Mackenzie Mountains (Caron *et al*. 2008), plus others in the Yukon, and British Columbia (COSEWIC 2014), although coordinates are not available for all of these locations. Of these, 63 springs within or immediately adjacent to Nahanni National Park Reserve have been assessed for Nahanni Aster habitat or populations, either during the above surveys or other park monitoring and research programs. As of 2020, Nahanni

Aster is extant at seven sites, with an estimated total abundance of 130,000 mature stems.

Species Range

Nahanni Aster is endemic to Canada and is known from only seven sites in Nahanni National Park Reserve, in the southern Mackenzie Mountains of the Northwest Territories (Figure 2). Nahanni Aster is thought to either have persisted in unglaciated refugia through the last glacial maximum (roughly 22,000 years ago) or to have evolved following deglaciation of the region around 11,000 years ago (Harris *et al*. 2014). All seven subpopulations of the species are within 150 km of each other and are associated with thermal springs, namely: 86-030, Gahnįhthah (Rabbitkettle), Old Pots, Persistent, Sibbeston, Thirteen Steps, and Wildmint springs (Figure 2).

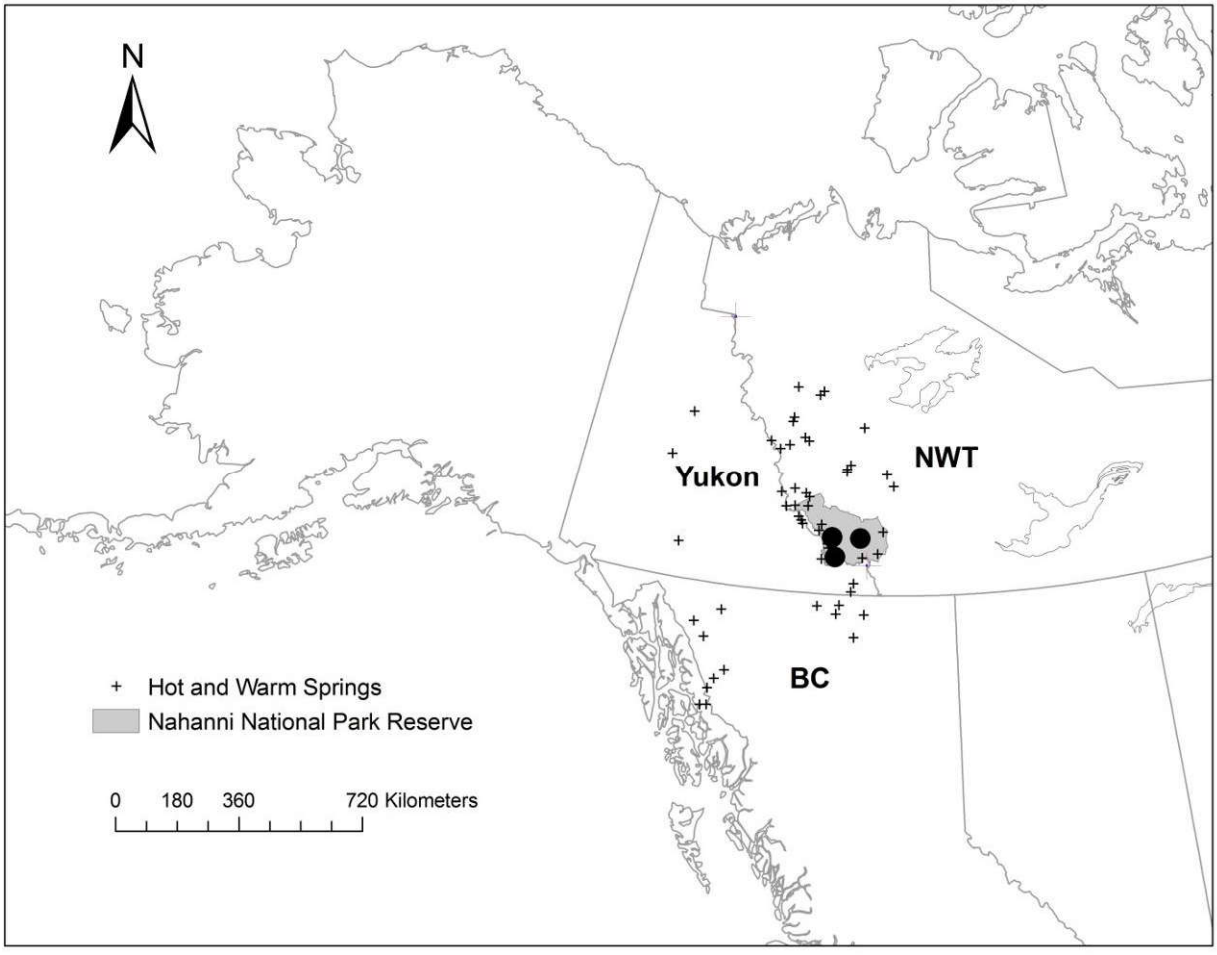

Figure 1: Global range of Nahanni Aster, with black dots representing the approximate locations of Nahanni Aster subpopulations, and crosses representing other hot and warm springs in north-western Canada (reproduced from COSEWIC 2014)

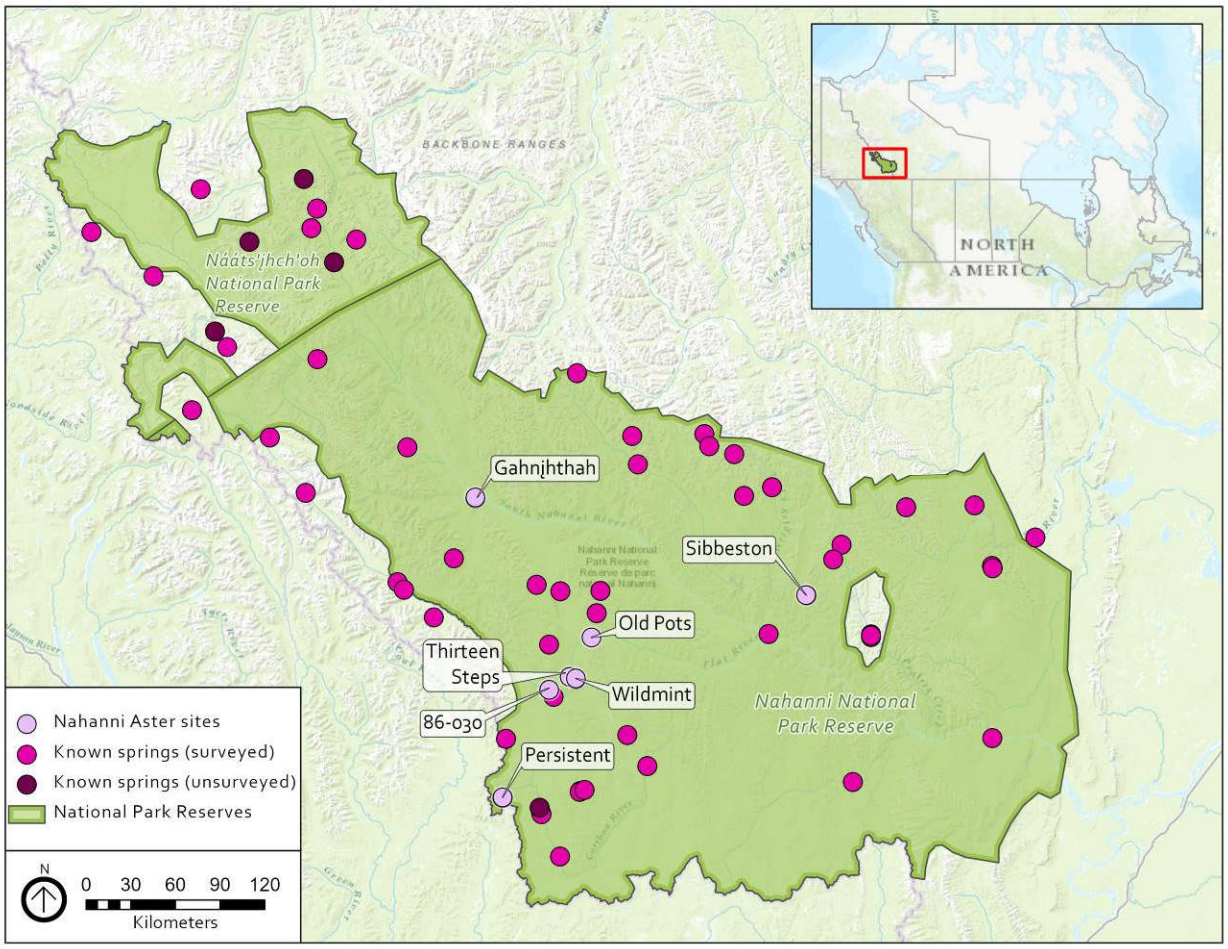

Figure 2: Distribution of the seven Nahanni Aster sites compared to surveyed and un-surveyed known springs (Harris & Foster 2012) in the southern Mackenzie Mountains.

Abundance

Abundance is difficult to measure for Nahanni Aster due to its clonal growth form. For the sake of population size estimates, “each flowering stem is treated as a ‘mature individual’ because each flower-bearing stem is inferred to be capable of reproduction” (COSEWIC 2014). Population estimates at each site in 2019 ranged between 538 (Persistent) and 51,231 (86-030), for a total of 130,000 mature individuals covering almost 30,000 m^2.

The total area estimated as occupied by the species in 2019 is approximately one-third of the 2012 estimate, which reflects the generally smaller per-site calculations of area occupied by Nahanni Aster in 2019 versus 2012 (Table 2). This is likely a methodological difference, however, rather than indicating a decline in area occupied. The 2019 estimates are more precise, being calculated as the sum of GPS polygons walked around aster locations, thus excluding gaps in the within-site distributions; whereas the 2012 areas were a quick, visual estimate of overall site area. Further, some of the 2019 calculations likely underestimate the true area occupied, as it was not

possible to GPS some downstream portions of the larger sites (e.g. Old Pots, Thirteen Steps, and Wildmint). Patterns between sites, however, are generally consistent over time, with larger sites having a greater area occupied by Nahanni Asters.

Table 2: Area (m^2) occupied by Nahanni Aster at each site in 2012 (Harris & Foster 2012) and 2019 (Parks Canada 2019)

	Survey year	
Nahanni Aster site	**2012**	**2019**
86-030	2,000	9,758
Gahnįhthah (Rabbitkettle)	400	295
Old Pots	10,000	2,008
Persistent	N/A	204
Sibbeston	10,000	972
Thirteen Steps	10,000	1,782
Wildmint	60,000	14,697
Total area occupied	92,400	29,716

Assessing trends in Nahanni Aster abundance is even more difficult due to the inconsistent count methods used in the three surveys. The 2003 and 2012 estimates were quick visual approximations of the number of mature stems, while 2019 estimates were calculated from in-field GPS records and stem count plots. The 2019 subpopulation abundance estimates were calculated by multiplying the minimum stem count by the lowest non-zero percentage of flowering and fruiting stems (since the 2019 survey took place in September, after peak flowering) at each site, then extrapolating to the total occupied area.

Of the four sites surveyed in all years, nearly three times more flowering individuals were recorded in 2012 than in 2003; while 2019 estimates were generally an order of magnitude larger than those in 2012 (Table 3). These different estimates likely do not reflect true changes in the abundance of Nahanni Aster, however, and should be interpreted with caution. More likely, they result from vastly different survey methods, timing and observers in the three different years, or year to year variability in growing conditions and the number of flowering stems. The methods developed and implemented in 2019 provide a more precise baseline and a more repeatable method for assessing abundance trends in the future. Patterns between sites were mostly consistent across years, with higher abundance at larger and comparatively wetter sites.

Table 3: Nahanni Aster mature individual abundance estimates from surveys in 2003 (COSEWIC 2014), 2012 (Harris & Foster 2012), and 2019 (Parks Canada 2019). Springs that weren't surveyed are marked "N/A". Caution should be used when comparing estimates from different years: 2003 and 2012 numbers are visual estimates, while stem count plots and GPS records of area occupied were used to calculate the 2019 abundance.

	Survey year		
Nahanni Aster site	**2003**	**2012**	**2019**
86-030	N/A	>1,035	51,231
Gahnįhthah (Rabbitkettle)	>50	203	943
Old Pots	>150	>1,000	40,158

Persistent	N/A	N/A	538
Sibbeston	N/A	900	6,806
Thirteen Steps	>100	>1,000	1,247
Wildmint	>1,000	>1,500	29,395
Total number of mature individuals	>1,350	>5,638	130,318

A count of mature stems may underestimate population abundance, since when vegetative stems are included, the total abundance estimate for 2019 was over 800,000 stems. Further, both stem density and the percentage of mature stems vary greatly between and within sites (Table 4), although they're not correlated (Figure 3). Variability is greatest at sites with more variable growing conditions ranging between dry tufa terraces and flowing spring waters (e.g. Old Pots, Thirteen Steps, Wildmint). Improving and expanding the monitoring program will provide a better understanding of this variability and its drivers.

Table 4: Variability in measures of Nahanni Aster abundance at the seven known sites in 2019. The ranges of stem density and percentage of mature stems are from counts at two to four monitoring plots per site. The area occupied was calculated from GPS records of plant locations at each sites. The number of mature individuals at the site level is calculated as the product of the lowest non-zero plot density and percentage maturity, across the area occupied. The number of stems is calculated as the product of the lowest non-zero stem density and the area occupied.

Site	Stem density range (stems/m^2)	% mature individuals range	Area occupied (m^2)	Number of mature individuals	Number of stems
86-030	35 - 74	15 - 50	9,758	51,231	341,540
Gahnı̨hthah (Rabbitkettle)	32 - 92	10 - 40	295	943	9,427
Old Pots	50 - 192	0 - 45	2,008	40,158	100,395
Persistent	132 - 167	0 - 2	204	538	26,910
Sibbeston	35 - 137	20 - 50	972	6,806	34,029
Thirteen Steps	14 - 140	5 - 80	1,782	1,247	24,946
Wildmint	20 -187	10 - 50	14,697	29,395	293,950
All Nahanni Aster sites	14 - 192	0 - 80	29,716	130,318	831,198

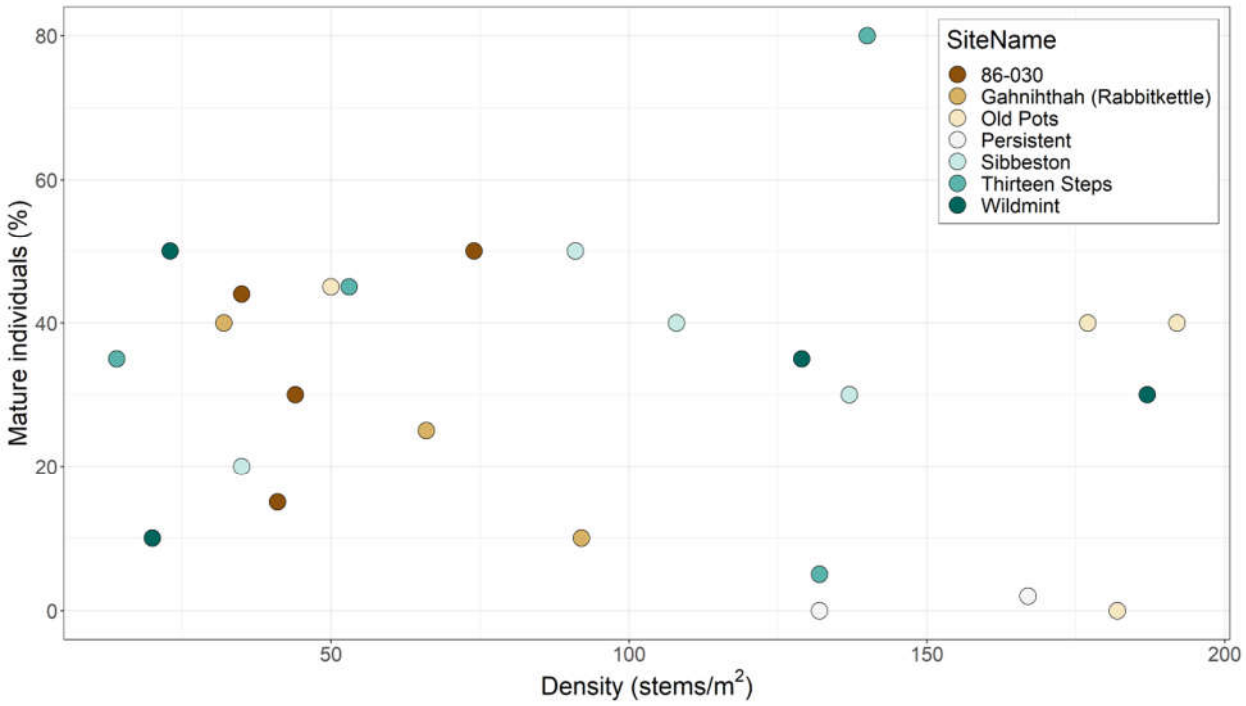

Figure 3: Density of Nahanni Aster stems and the percentage of mature individuals measured in 2019 at plots at the seven Nahanni Aster sites (Parks Canada 2019)

3.3. Needs of the Nahanni Aster

Habitat Requirements

Nahanni Aster habitat requirements are not well understood. Limited information on spring water temperature and chemistry was collected during geological (Caron *et al*. 2008) and hydrological (Lepitzki and Lepitzki 2004) studies, but these reflect site-level conditions rather than growing habitat. Consequently, some parameters were measured adjacent to plots in the 2019 surveys (Table 5), and additional plot conditions (e.g. canopy cover, soil moisture) have been identified for potential inclusion in future surveys. Further work is also needed to clarify how the habitat conditions at Nahanni Aster sites differ from other thermal springs in the Mackenzie Mountains.

All subpopulations found to date are at the edges, seepages, and channels of a limited number of thermal springs with some form of calcium deposit or tufa. Thermal springs are groundwater discharge points where the water is more than 10˚C above the mean annual air temperature (Lepitzki and Lepitzki 2004). This presumably provides more consistent water and nutrient supplies and moderate temperatures, throughout the year. Consequently, even though site elevation—a proxy for average temperature—varies from 643 to 1,089 m.a.s.l., temperatures at all sites appear to be consistent enough to support Nahanni Aster subpopulations. Further, data from the 2019 survey indicates that warmer air temperatures and deeper water near stem count plots are associated with taller Nahanni Asters, and more flowering or fruiting stems. Staff observed similar

patterns at the site level, i.e. comparatively drier sites such as Gahnįhthah (Rabbitkettle) had sparser, smaller, more vegetative plants.

Water temperatures at the Nahanni Aster stem plots ranged from 9.5°C to 22°C (Parks Canada 2019). These ranges include the maximum temperatures measured at each spring, except for Sibbeston and Wildmint, where maximum temperatures are respectively 1°C and 10°C higher than plot-adjacent temperatures; but it is unknown how close Nahanni Aster grows to the hottest parts of these springs. The water temperature at Old Pots is significantly lower than at the other sites; this site is thought to have been a warm or hot spring that subsequently cooled. Nahanni Aster may thus be able to persist in cooler conditions, provided that other habitat requirements are present.

Tufa is a precipitate of ground water saturated with calcium carbonate, left behind when it reaches the surface and releases carbon dioxide. This precipitate gradually accumulates over thousands of years to form terraces, mounds, and gours (bathtub-like pools). Calcium deposits are present at the Nahanni Aster sites in various forms, from minor deposits in the soil at Persistent spring, to calcium carbonate encrusted rocks at Sibbeston spring, and weathered dry tufa terraces and gours at Old Pots and Thirteen Steps. The water chemistry at Nahanni Aster sites generally reflects this geology and is basic or slightly acidic (Caron *et al*. 2008; note, Thirteen Steps was not sampled in this study). Nutrients may also be more available in springs, however trace element concentrations at the Nahanni Aster sites are low, even at 86-030 that has extensive red mounds containing iron oxides (Table 5), and there is little comparative data from other surface water habitats to test this hypothesis. Additionally, the 2019 data indicates that stem density decreases as conductivity increases, so there may be an upper limit to the benefits of higher dissolved nutrients.

Nahanni Aster typically grows in open areas of the springs, unshaded by trees or shrubs. It is mostly found rooted in “brown mosses” (e.g., Golden Fuzzy Fen Moss (*Tomentypnum nitens*) and Fernleaf Hook Moss (*Cratoneuron filicinum*)), but also occurs in broken old tufa, and dense turf with various species of rushes and sedges (Owen *et al*. 2006; COSEWIC 2014).

Table 5: Elevation, water temperature, and water chemistry data collected at thermal springs with confirmed Nahanni Aster subpopulations (COSEWIC 2014; Caron et al. 2008; Parks Canada 2019)

Nahanni Aster site	Spring elevation (m)[4]	Spring max water temperature (°C)[4]	Water temperature range at plots (°C)[5]	pH range at plots[6]	Conductivity range at plots (us/cm)[6]	Total trace elements (%)[6]
86-030	706	19	16.3 - 20.1	6.82 - 7.22	586.1 - 713	0.54
Gahnįhthah (Rabbitkettle)	642	22	Not measured	Not measured	Not measured	0.12
Old Pots	663	10	9.5 - 10.5	7.38 - 7.69	313.4 - 323.3	0.14
Persistent	1,089[6]	Unknown	14.5 - 17.5	7.15 - 7.16	589.5 - 640	0.26
Sibbeston	795	18	16.1 - 16.9	7.06 - 7.18	286.9 - 377.9	0.31
Thirteen Steps	667	14	17.7 - 18.4	6.9 - 7.56	576 - 817	Not measured
Wildmint	677	29	13.0 - 19.4	6.89 - 7.12	579.8 - 693	0.09

Even less is known about how Nahanni Aster habitat conditions change throughout or between years. Current site conditions appear to be relatively stable, as water parameters measured in 2019 were generally consistent with earlier measurements at the same springs (Caron *et al*. 2008), and intermittent monitoring by Parks staff at some of the more well-known sites (Gahnįhthah (Rabbitkettle), Old Pots, and Wildmint) since the 1980s has not detected any consistent damage to tufa (Catto 1987; Gulley 1993) or large-scale changes to vegetation at the springs (Tate 2012). Nevertheless, conditions may have changed historically (e.g. water temperatures at Old Pots); or may change in the future, as air temperatures and precipitation appear to be increasing across the Nahanni region, particularly in summer (Parker 2018).

Limiting Factors

The scarcity and highly dispersed nature of suitable habitat is believed to be the major limiting factor for Nahanni Aster. This theory is supported by the fact that there are other known springs with tufa deposits in Nahanni National Park Reserve where Nahanni Aster does not occur (Harris & Foster 2012). Despite having many characteristics of suitable habitat, the total area of these additional sites is estimated to be less than 1 km^2 spread over the 30,000 km^2 area of the park. There is therefore a low probability that wind-borne seeds from known subpopulations will successfully disperse to and establish at these preferred spring habitats, with seemingly ideal biophysical characteristics.

The extremely limited range of Nahanni Aster (seven occurrences covering less than 0.1 km^2 in total) make it particularly vulnerable to threats associated with small population size, including random environmental events that frequently occur in the Nahanni region (e.g., earthquakes and landslides). Although there are additional un-surveyed springs in the Nahanni area, it is unlikely that more than another ten have

[4] COSEWIC 2014
[5] Parks Canada 2019
[6] Caron *et al*. 2008

Nahanni Aster subpopulations, based on the discovery rate from past surveys (seven subpopulations found from 63 surveyed springs, of approximately 150 known springs in the area (Caron *et al*. 2008)).

Apart from the species scarce habitat, potential limiting factors are poorly understood. While insects such as butterflies, bumblebees, and moths are known to pollinate Nahanni Aster flowers, population impacts from herbivory, insect damage, or plant diseases are unknown. Similarly, no information exists about any physical impacts to Nahanni Aster habitat from trampling by ungulates (e.g. Moose (*Alces americanus*) and Woodland Caribou (*Rangifer tarandus caribou*)) or to plants from foraging by wildlife (e.g. birds, rodents).

4. Threats

4.1. Threat Assessment

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

The Threat Assessment presented in COSEWIC (2014) was updated for this management plan, based on additional information from the 2019 survey and other park monitoring programs. Threat 6.1 Recreational acitivities was changed to Threat 6.3 Work & other activities since staff or researchers are considered more likely than visitors to access the Nahanni Aster sites. Further, 7.1 Fire & fire suppression and 11.2 Droughts were considered as potential threats for the first time. Fire is a driving process for vegetation communities in the Nahanni region, and recent droughts in 2014-15 were found to have affected plant growth elsewhere in the NWT (Martin & Pisaric, 2017).

Table 6: Threat Assessment based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system.

Threat #	Threat description	Impact[a]	Scope[b]	Severity[c]	Timing[d]	Detailed threats
6	Human intrusions & disturbance					
6.3	Work & other activities	Negligible	Small	Negligible	High	Sites are protected under the Canada National Parks Act and access by staff, researchers and visitors is limited and regulated.
7	Natural system modifications					
7.1	Fire & fire suppression	Not a Threat	Restricted	Neutral or Potential Benefit	Low	Fire frequency and intensity may increase with climate change, but clonal regeneration may prevent impacts to population abundance.
8	Invasive & other problematic species & genes					
8.1	Invasive non-native/alien species	Negligible	Negligible	Slight	Low	Best management practices regulate introductions from visitors to the springs; mining access roads as vectors for alien plant species introduction are 30-200 km from Nahanni Aster sites.
10	Geological events					
10.2	Earthquakes/tsunamis	Negligible	Negligible	Moderate	Low	Earthquakes are common, but would have secondary and speculative impacts to Nahanni Aster habitat through alterations to groundwater discharge.
10.3	Avalanches/landslides	Negligible	Negligible	Serious	Moderate	Only Sibbeston spring is in a landslide-prone region.
11	Climate change & severe weather					
11.1	Habitat shifting & alteration	Unknown	Pervasive	Unknown	High	The Nahanni climate change assessment indicates that the region may be getting warmer and wetter, especially in winter and spring. But nothing is known about how Nahanni Aster might respond to such changes.
11.2	Droughts	Unknown	Pervasive	Unknown	Moderate	Drought periods may occur despite climate trends towards more precipitation. It is unknown how reduced surface water availability might affect Nahanni Aster growth or reproduction.

[a] **Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%),

and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment timeframe (e.g., timing is insignificant/negligible or low as threat is only considered to be in the past); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

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

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

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

4.2. Description of Threats

Nahanni Aster is endemic to Canada, with only seven known subpopulations located within a remote and relatively small geographic area in Nahanni National Park Reserve. Since the entire known population of Nahanni Aster is within a National Park Reserve, it is protected under the Canada National Parks Act (S.C. 2000, c. 32). The primary limitations are the species small range and population size, but there are no significant threats. Outlined below are some potential low risk threats.

IUCN Threat 6. Human Intrusions & Disturbance

Threat 6.1 Work & Other Activities - Negligible impact

All known Nahanni Aster subpopulations are found within Nahanni National Park Reserve and are therefore protected under the Canada National Parks Act (S.C. 2000, c. 32) and associated regulations. Additionally, the Nahanni Aster sites are mostly remote from visitor use areas, not well known to the public, and require special permits for motorized access (Figure 4). Consequently, visitation is extremely low; meanwhile, any researchers and staff conducting work at the springs must additionally abide by cultural protocols and Nahanni's best management practices (BMPs) for eco-tourism and aircraft landings. Cultural protocols, for example, only allow visitors to the Gahnı̨hthah tufa mound that does not have Nahanni Aster, and require barefoot access to prevent damage to this significant cultural site. Nahanni's BMPs further outline mechanisms to mitigate invasive species introductions and avoid trampling riparian vegetation. Work or other activities at the sites thus pose little risk of trampling Nahanni Aster plants or their delicate tufa habitat.

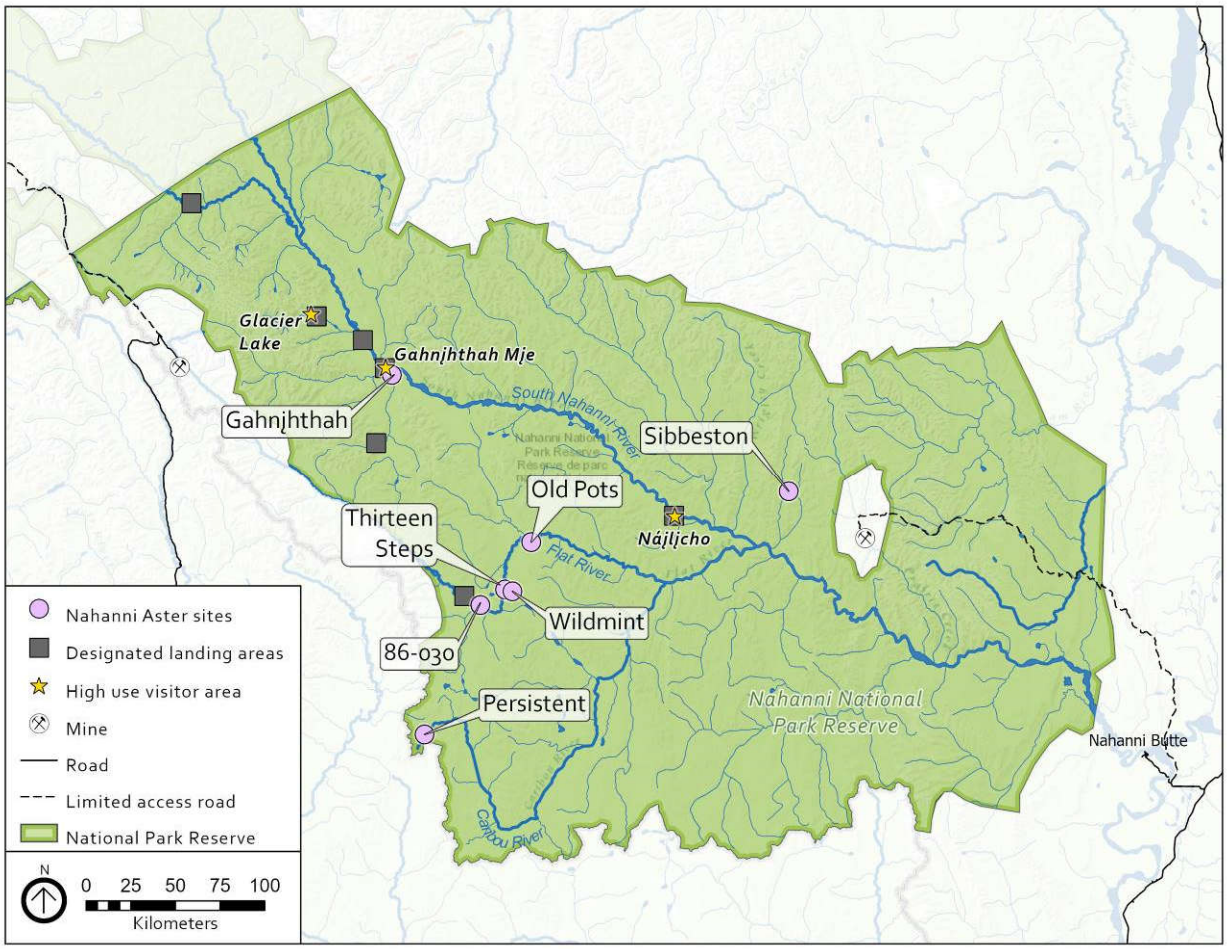

Figure 4: The seven known Nahanni Aster sites, in relation to visitor use and access within Nahanni National Park Reserve

IUCN Threat 7. Natural system modifications

Threat 7.1 Fire & fire suppression – Not a threat

Nahanni National Park Reserve does not conduct either prescribed burning or fire suppression activities, however, climate change may increase future wildfire frequency or severity that could impact Nahanni Aster subpopulations, particularly in the spring or summer (Sullivan 1992). The likelihood is considered low, however, since historic fire data shows only a single fire since 1971 overlapping any known Nahanni Aster sites (86-030, Thirteen Steps, and Wildmint; Parks Canada 2018). Since all these sites still contain Nahanni Aster, the subpopulations may have regenerated from rhizomes; it is possible that Nahanni Aster, like other *Symphyotrichum* species, could even benefit from nutrient influxes and reduced vegetation encroachment following a wildfire (Bizecki Robson 2010).

IUCN Threat 8. Invasives & other problematic species & genes

Threat 8.1 Invasive non-native/alien species – Negligible impact

Invasive species are considered a potential future threat to Nahanni Aster. To date, thirteen species of non-native plants have been recorded in Nahanni National Park Reserve, primarily at one location (Parks Canada 1997); however, climate change may facilitate the spread and establishment of many alien species and create new opportunities for them to invade and compete with native species (IUCN 2020). Additionally, the development of two mining access road corridors through the park reserve (one active and proposed for expansion, the other permitted for construction) may provide a vector for the introduction of invasive species to the region (Oldham & Delisle-Oldham 2017), although still at a distance of 20 km or more from known Nahanni Aster sites. The most likely vector is the unintentional transport of invasive species on equipment when park staff, researchers and visitors access Nahanni Aster sites. If invasive plants are introduced at a spring, the temperate growing conditions may allow easier establishment, as shown at the historically disturbed site of the Kraus homestead (Scotter & Cody 1974, Cody *et al*. 1979, Bennett 2013).

Little is known about other potential invasive species such as pathogens, insects, or mammals in the Nahanni region. Forest insect infestation levels have been monitored annually along the South Nahanni and Flat River corridors within Nahanni since 1985, but no trends are apparent in this data. Community observations and pathways analysis (Snyder & Anions 2008; GNWT 2018) indicate that species such as deer, pigs, and insects could expand their ranges northward into the southern NWT; but the potential effects of such species arrival (e.g. predation, damage to habitat, or out-competing other pollinators) on Nahanni Aster are speculative given our limited knowledge of Nahanni Aster ecological interactions.

IUCN Threat 10. Geological events

Threat 10.2 Earthquakes/tsunamis – Negligible impact

The area surrounding Nahanni National Park Reserve is one of the most seismically active regions in Canada (Figure 5; Cassidy *et al.* 2010; Wetmiller *et al.* 1988). Seismic activity (e.g., fault movement and earthquakes) can alter or stop thermal spring flow, even at sites located hundreds of kilometers away from the epicenter (Grasby, pers. comm.; Mazzotti & Hyndman 2002). Stem counts in 2019 indicate that Nahanni Aster prefers wet growing conditions, so alterations to groundwater discharge have the potential to reduce the availability of preferred Nahanni Aster habitat and decrease abundance. Nevertheless, subpopulations may be able to persist despite such groundwater changes, as appears to be the case at Old Pots, which is thought to have cooled from a hot to warm spring as the result of seismic activity.

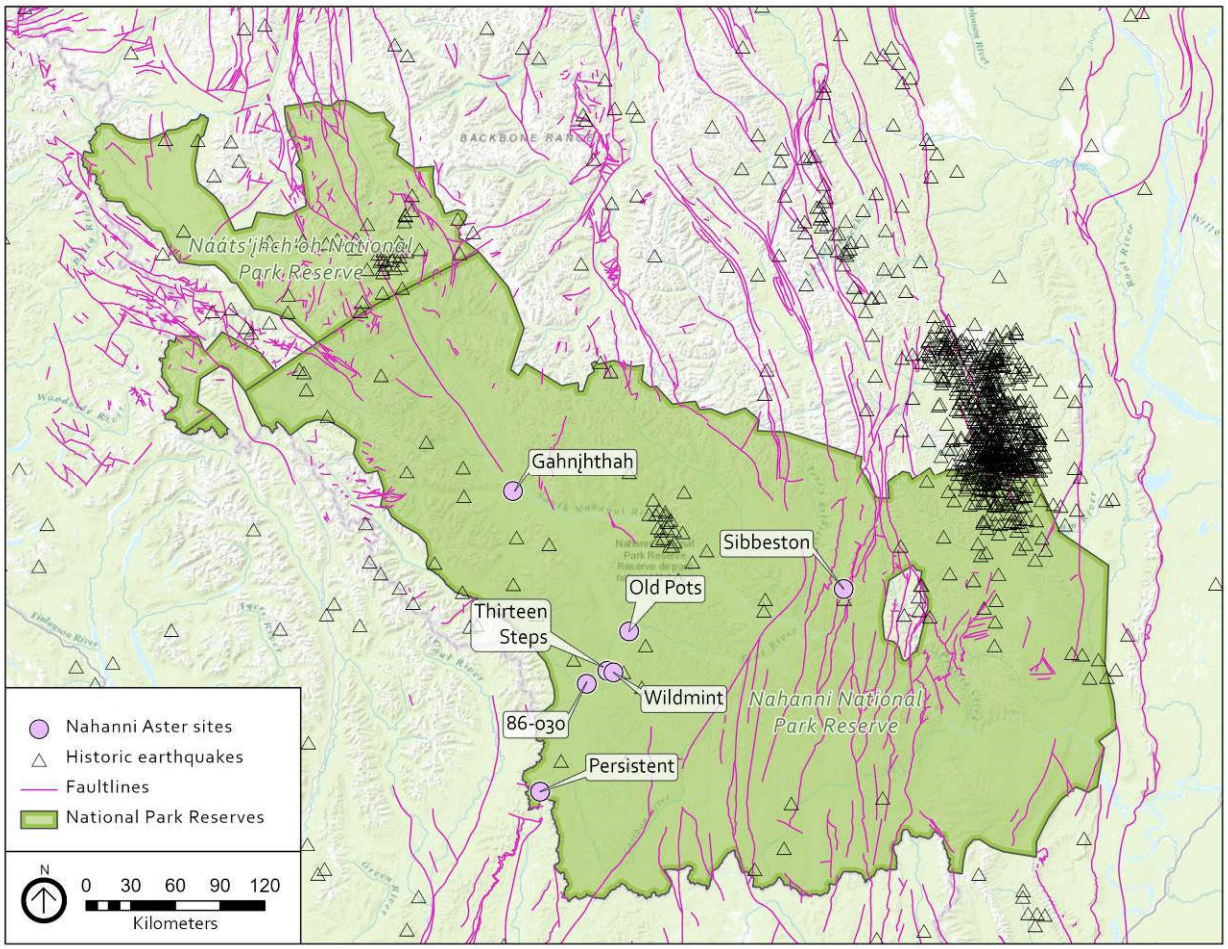

Figure 5: The seven Nahanni Aster sites compared to geologic faults (Okulitch & Irwin 2017) and 1985-2020 earthquake epicentres (Earthquakes Canada 2020) in the southern Mackenzie Mountains

Threat 10.3 Avalanches/landslides – Negligible impact

Seismic activity can also cause soil slumping, rock fall, and landslides. Other springs have been reported as destroyed by landslides in the Mackenzie Mountains (Woodsworth & Woodsworth 2020) and northern British Columbia (Arnold pers. comm.), so such activity has the potential to destroy or severely damage a Nahanni Aster subpopulation. None of the identified subpopulations occur in the Tlogotsho Range or the Ram Plateau, the two most slide-prone areas of the park (Jermyn & Menounos 2006; Jermyn *et al*. 2006), so there is a low likelihood of landslides occurring at the sites. Park staff have reported new slumping in recent years, including a 2019 observation of a landslide approximately two kilometres from Sibbeston spring that had almost completed blocked a stream. This may indicate changing avalanche and landslide dynamics as a result of climate change-induced permafrost thaw.

IUCN Threat 11. Climate change & severe weather

Threat 11.1 Habitat shifting & alteration – Unknown impact

Climate change is the most likely driver of change to thermal springs and conditions that support Nahanni Aster growth, but any impacts are speculative. Mean annual seasonal temperatures in and around Nahanni National Park Reserve have been steadily increasing, with the greatest temperature increases occurring in winter; a similar trend is occurring for annual and seasonal precipitation (Parker 2018, Canadian Centre for Climate Services, 2018). During summer months, increases in temperature and precipitation have resulted in longer and warmer growing seasons, and higher August rainfall. This could affect Nahanni Aster population growth, but as described in Section 3.1 nothing is known about seed germination or maturation, or how these could respond to a longer growing season. There is more winter precipitation (snowfall), but higher winter temperatures have resulted in a decreased snowpack and an earlier spring (Parks Canada 2009). It is unclear how these temperature and precipitation fluctuations might alter runoff and groundwater discharge, or if this will increase or decrease existing Nahanni Aster habitat.

Threat 11.2 Droughts – Unknown impact

Although the future climate is generally expected to be warmer and wetter, climate change is also projected to lead to an increase in extreme weather events, including heat waves and droughts (Parker 2017). Drought periods can reduce soil moisture, and may affect runoff and spring recharge (Fang & Pomeroy 2008; Bonsal et al. 2011). In addition, increasing summer temperatures may lead to more evapotranspiration and contribute to creating drought conditions. The NWT experienced a drought in 2014-15, which is suspected to have led to impacts on vegetation including increased fires, and dieback of pine trees (Martin & Pisaric, 2017).The preliminary analysis of 2019 plot data indicated that that Nahanni Aster may grow more prolifically and flower (i.e. reproduce) better in wetter growing conditions. It is unknown whether this would affect population dynamics in the long term, or whether any annual impacts would be mitigated by groundwater discharge from the springs, or by plant regeneration from rhizomes or the seed bank.

5. Management Objective

As identified in Section 4, most threats to Nahanni Aster are currently considered negligible, and largely mitigated since all known subpopulations are protected within a national park reserve. The greatest conservation concerns relate to the species limiting factors of a very small range and population size that reduces its resiliency in the face of changing climate and potential resulting alterations to habitat. Lack of knowledge about Nahanni Aster is also a primary limitation for management planning and species conservation.

The objective of this management plan is thus to continue to protect and maintain the distribution and abundance of the Nahanni Aster population, while improving our understanding of the species ecological role and requirements, and promoting awareness of the species, possible threats, and research opportunities.

6. Broad Strategies and Conservation Measures

6.1. Actions Already Completed or Currently Underway

To date, three surveys (in 2003, 2012 and 2019) have been completed to confirm existing and identify new Nahanni Aster subpopulations, and estimate abundance (Section 3.2). The 2019 survey established long-term monitoring plots and methods.

Nahanni Aster was a focus of Nahanni National Park Reserve social media[7] and written communications products in 2017 and 2019, with the goal of increasing awareness of the species both within management agencies and the general public. Information about Nahanni Aster is also shared through the NWT Species at Risk program via the program website[8] and the Species at Risk in the NWT booklet (Government of the Northwest Territories 2020).

Other ecological integrity monitoring programs provide general information on some threats to Nahanni Aster across the park reserve, including invasive plant species establishment and distribution, fire frequency and extent, and trends in air temperature and precipitation.

The 2020 Nahanni National Park Reserve DRAFT Management Plan (Parks Canada 2020) formalized park zoning in the areas surrounding all Nahanni Aster sites as either Zone II Wilderness or Zone I Special Preservation Areas. Recent improvements to park permitting processes, including the development of best management practices for aircraft access, provide stronger protection against impacts to Nahanni Aster subpopulations and habitat from park users.

6.2. Broad Strategies

Progress towards the objective of this management plan will be achieved over the next five years through targeted inventories, monitoring, and assessment of known and potential subpopulations and habitat; supporting species-specific research; and communications activities to increase park user knowledge of Nahanni Aster and potential threats.

[7] https://www.facebook.com/ParksCanadaNWT/photos/a.475948819208442/1679863328816979
[8] https://www.nwtspeciesatrisk.ca/species/nahanni-aster

6.3. Conservation Measures

Table 7: Conservation Measures and Implementation Schedule

Conservation Measure	Priority[e]	Threats or Concerns Addressed	Timeline
1. Outreach and Communications			
1.1 Develop and implement outreach and communications activities regarding Nahanni Aster and potential threats.	Medium	Work & other activities Invasive non-native/alien species	Ongoing
2. Basic Research and Status Monitoring			
2.1 Develop partnerships to survey additional known springs with suitable habitat characteristics inside and outside Nahanni National Park Reserve, to determine Nahanni Aster presence/absence.	High	Limiting factor (scarcity and highly dispersed nature of suitable habitat) Habitat shifting & alteration	2026
2.2 Engage with Indigenous knowledge holders and communities to learn more about Nahanni Aster and its habitat.	Medium	Limiting factor (scarcity and highly dispersed nature of suitable habitat) Habitat shifting & alteration Droughts Fire & fire suppression Earthquakes/tsunamis Avalanches/landslides	2026
2.3 Continue to monitor changes to status and trend in Nahanni Aster subpopulations and habitat.	Medium	Droughts Habitat shifting & alteration Invasive non-native/alien species Earthquakes/tsunamis Avalanches/landslides	Ongoing
2.4 Encourage and collaborate with research on Nahanni Aster ecology and potential alterations to habitat.	Medium	Limiting factor (scarcity and highly dispersed nature of suitable habitat) Habitat shifting & alteration Droughts Fire & fire suppression Earthquakes/tsunamis Avalanches/landslides	Ongoing
3. Policies and Guidelines			
3.1 Update information on park research priorities and permitting processes to minimize impacts at Nahanni Aster sites from research activities.	High	Work & other activities	2022
3.2 Ensure that impacts to rare plants are considered, monitored for, and mitigated during environmental assessment and permitting processes.	Low	Invasive non-native/alien species Work & other activities Habitat shifting & alteration	Ongoing

[e] *"Priority" reflects the degree to which the measure contributes directly to the conservation of the species or is an essential precursor to a measure that contributes to the conservation of the species. High priority measures are considered those most likely to have an immediate and/or direct influence on attaining the management objective for the species. Medium priority measures may have a less immediate or less direct influence on reaching the management objective, but are still important for the management of the population. Low priority conservation measures will likely have an indirect or gradual influence on reaching the management objective, but are considered important contributions to the knowledge base and/or public involvement and acceptance of the species.*

6.4. Narrative to Support Conservation Measures and Implementation Schedule

Broad Strategy 1: Outreach and Communications

The Nahanni Aster has an extremely limited distribution, and is consequently not well known to the public. Communication strategies may be both internal and external, and will target local Indigenous land users, local and regional residents, park visitors and researchers, as well as broader national and international audiences. Communication activities will raise awareness of the species and threats to the population, and may encourage visitors to adopt minimal impact travel practices or to document aster or invasive species observations. Communication will be undertaken using a variety of outlets, which may include social media; web articles; pamphlets; national programs such as PlayCleanGo (PlayCleanGo 2020) and Leave No Trace (Leave No Trace Canada 2009); signage; educational outreach; community visits; direct conversations with Indigenous land users, visitors, researchers and co-management partners; conferences or publications; and media approaches.

Broad Strategy 2: Basic Research and Status Monitoring

Three surveys have been conducted (in 2003, 2012, and 2019) to determine Nahanni Aster distribution and broad measures of abundance; however methodological inconsistencies between surveys mean that little is known about population trends and fluctuations. A long-term monitoring plan was established during the 2019 survey, but requires review to determine any additional monitoring requirements and to establish thresholds for management action.

Other existing park monitoring programs—in particular, programs to monitor changes in climate, spring conditions, and human footprint from increasing visitation—should be leveraged to better understand broad ecosystem changes and developing threats that may impact Nahanni Aster. Similarly, encouraging and supporting targeted research on Nahanni Aster and threats may address specific knowledge gaps that remain regarding Nahanni Aster biology, population connectivity among sites, ecological role, and habitat requirements. Further, Indigenous knowledge may provide insight not only into the species and its thermal spring habitat, but also ongoing landscape changes, and culturally informed recovery actions, to ensure that future management decisions are more informed. Parks Canada will engage with Indigenous communities to determine how to respectfully document this knowledge, and apply their expertise in ongoing surveys and monitoring. This will include engaging with local Indigenous communities to further the idea of conducting Indigenous traditional use and ecological knowledge interviews. Methods used to engage with members of other local Indigenous groups will depend on ongoing partnerships and discussions.

Finally, there are at least nine known thermal springs in the vicinity of Nahanni National Park Reserve that have potentially suitable conditions for Nahanni Aster growth but have not been surveyed; and there may be additional spring locations further from the

park or that have not been documented. Collaborating with Indigenous communities, other jurisdictions and research partners to identify and survey these additional sites is a priority, to better understand Nahanni Aster population size, distribution, and habitat requirements.

Working with Indigenous organizations and members to continue to better understand and monitor the Nahanni Aster population will be important to the success of this strategy. In particular Parks Canada will engage further with Indigenous community organizations who have an interest in participating in future monitoring and research projects related to Nahanni Aster.

Broad Strategy 3: Policies and Guidelines

Visitor (including researcher) access to the Nahanni Aster sites is managed through Park zoning and research permitting, as well as best management practices for aircraft access and ecotourism. This information can be more effectively communicated to researchers interested in working on Nahanni Aster or at the thermal springs where it is present, through updates to Nahanni National Park Reserve's research and collection permit system.

Developments in Nahanni NPR that have the potential to introduce invasive species are subject to environmental assessment (EA) under the Mackenzie Valley Resource Management Act (S.C. 1998, c. 25). For major projects in Nahanni NPR, Parks Canada participates in the EA process lead by the Mackenzie Valley Environmental Impact Review Board. Following that, for projects that the federal minister responsible for Parks Canada approves, Parks Canada is responsible for issuing permits. Thus for major projects, the potential for invasive species introduction and for other impacts to plant habitat or rare species such as Nahanni Aster can be considered and mitigated at multiple stages throughout this process, including scoping, environmental assessment, management plan approvals, and inspection.

7. Measuring Progress

The performance indicators presented below provide a way to measure progress towards achieving the different components of the management objective, and monitoring the implementation of the management plan.

- protect and maintain the distribution of Nahanni Aster:
    - By 2026, Nahanni Aster is present at each of the seven known sites of 86-030, Gahnįhthah (Rabbitkettle), Old Pots, Persistent, Sibbeston, Thirteen Steps, Wildmint.
    - By 2023, Parks Canada has collaborated with external jurisdictions to identify additional known springs in the vicinity of Nahanni National Park Reserve with potential Nahanni Aster habitat.
- protect and maintain the abundance of the Nahanni Aster population:

    - By 2026, thresholds have been established against which ongoing abundance monitoring can be compared.
    - Annually, all business license holders and researchers working in Nahanni National Park Reserve adhere to license conditions and best management practices for any work at Nahanni Aster sites.
- improving our understanding of species ecological role and requirements:
    - By 2026, the monitoring protocol has been reviewed and any additional requirements have been identified for monitoring Nahanni Aster subpopulations or habitat at the seven known sites of 86-030, Gahnįhthah (Rabbitkettle), Old Pots, Persistent, Sibbeston, Thirteen Steps, Wildmint.
    - By 2026, a gap analysis has been completed that incorporates new traditional knowledge and all monitoring and research undertaken during the life of this management plan, to assess remaining information needs and priorities.
- promoting awareness of the species, possible threats, and research opportunities:
    - By 2022, Nahanni Aster research questions are included in the Nahanni National Park Reserve research priorities.
    - At least one outreach or communications activity focused on Nahanni Aster or potential threats is implemented annually to 2026.

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Appendix A: Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[9]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[10] (FSDS) goals and targets.

Conservation planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that implementation of management plans may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the management plan itself, but are also summarized below in this statement.

The conservation measures outlined in this management plan are not expected to have any significant impact on either the environment or other species.

[9] www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html
[10] http://www.fsds-sfdd.ca/index.html#/en/goals/