

**Recovery Plan for Crowded Wormseed Mustard
(*Erysimum inconspicuum* (S. Watson) MacMill.
var. *coarctatum* (Fernald) Rossbach)
in Newfoundland**



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LEAD JURISDICTION/ OTHER JURISDICTION/ KEY CONTACTS

Lead: Government of Newfoundland and Labrador, Department of Environment and Conservation, Wildlife Division.

DISCLAIMER

This recovery plan for the Crowded wormseed mustard (*Erysimum inconspicuum* (S. Watson) MacMill. var. *coarctatum* (Fernald) Rossbach) has been prepared by the members of the Crowded Wormseed Mustard Recovery Team. The document defines the goals and objectives deemed necessary to protect and recover the Crowded Wormseed Mustard. It does not necessarily represent the official positions of the governmental or non-governmental organizations, or individuals, involved. The recovery goals and objectives identified in this strategy are based upon the best knowledge available and may change over time in light of new findings and revised priorities. Implementation of the goals and objectives identified in this document ultimately depend upon the ongoing program priorities and budgetary constraints of the participating departments and organizations.

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COVER PHOTOGRAPH

Crowded wormseed mustard, by Michael Burzynski

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PREFACE

Crowded wormseed mustard is a herbaceous biennial or short-lived perennial in the Mustard Family that has only been found in one small area of coastal basalt cliffs on the west coast of the Island of Newfoundland. It was listed as Endangered under the Newfoundland and Labrador *Endangered Species Act* in 2007.

This will be the first recovery plan for Crowded wormseed mustard, and it outlines the recovery objectives for 2009 to 2013.

EXECUTIVE SUMMARY

Crowded Wormseed mustard is a yellow-flowered, biennial or short-lived perennial herb in the mustard family. Within the Province of Newfoundland and Labrador it is known from only one location on the west coast of Newfoundland between the Bay of Islands and Gros Morne National Park. In 1995 the number of flowering plants was estimated as 100. During the most recent visit to the site in August 2000 the plants were not observed, possibly because they had withered after setting seed. It is not known whether the species' population size or distribution has changed since the initial discovery of the species in Newfoundland.

The population is located at the edge of a basalt cliff. A steep meadow adjoining the cliff is grazed by cattle and horses from Trout River, and herbivory may threaten the Crowded wormseed mustard. The population location makes it susceptible to slope failure. Six seasonal cabins are located on the south side of Gregory River approximately 500m from the Crowded wormseed mustard plants. An ATV trail has been constructed, which will permit more frequent visitation to the area.

The primary goal of this recovery plan is to secure the long-term persistence of the Endangered Crowded wormseed mustard in the Province of Newfoundland and Labrador in its natural habitat, in more than one population.

The specific recovery objectives for Crowded wormseed mustard are:

1. to determine the population size, distribution, reproductive biology and ecology of the species to facilitate other recovery actions;
2. to clarify existing threats and to determine whether there are other as-yet-unidentified threats;
3. to further identify land uses and work with land users to develop acceptable mitigations;
4. to prevent population decline and extirpation resulting from controllable factors, such as grazing pressure and ATV use;
5. to establish an *ex situ* population large enough to reintroduce the species if it should become extirpated from its natural habitat in Newfoundland; and
6. to ensure that there are at least two known sites in NF with a viable population, using introduction of the species outside of its known range, if necessary.

Specific recovery actions to achieve these objectives or address existing threats include:

- Population Inventory and Monitoring (search for additional populations and suitable habitat, population counts, monitoring)
- Scientific Research (ecology, reproduction, seed bank, herbivory and pathology, genetics)
- *Ex Situ* Conservation (seed banking, live collection)

- Population Introduction
- Population and Habitat Management (interim habitat protection, livestock exclosures, Critical Habitat assessment and protection)
- Education and Stewardship (consultations with site users, information dissemination to Conservation Officers)

It is probable that during the next site visit several of these recovery actions can be conducted concurrently. The information obtained from this visit, as well as the results from a survey of other potentially suitable habitat areas, will serve to reprioritize the remaining recovery actions.

Interim protection for the site will be sought by designating the area a Sensitive Wildlife Area as this will bring any further development sought at the site to the attention of the Wildlife Division.

If no further Crowded wormseed mustard sites are discovered, an attempt will be made to introduce the species into at least one other Newfoundland location with suitable habitat.

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1. SPECIES INFORMATION

1.1 Species Assessment Information from the Species Status Advisory Committee

This section was updated with current information obtained since the assessment.

Common Name:	Crowded wormseed mustard
Scientific Name:	<i>Erysimum inconspicuum</i> (S. Watson) MacMill. var. <i>coarctatum</i> (Fernald) Roszbach = <i>Erysimum coarctatum</i> Fernald
Global Occurrence:	<ul style="list-style-type: none"> • <i>Erysimum inconspicuum</i> is a North American endemic, found from Yukon Territory and Alaska to Newfoundland, and as far south as Kansas • var. <i>inconspicuum</i> Ontario to Yukon Territory • var. <i>coarctatum</i> Newfoundland and Labrador to Yukon Territory
Newfoundland and Labrador Occurrence:	A single occurrence at Chimney Cove in western Newfoundland between the Bay of Islands and Gros Morne National Park
Provincial Legal Status:	Endangered
Status History:	Designated Endangered in 2007
Reason for Designation:	<ul style="list-style-type: none"> • Only one known population • Narrowly restricted to a very unstable habitat (30 m band at the upper edge of a friable cliff along ocean coast) • Small population, estimated at 100 mature individuals over ten years ago (not surveyed since) • Biennial or short lived perennial reliant on soil seed bank • Cattle grazing and increased human use at the site could pose a threat • Rescue effects unlikely due to 460 km distance to closest known extant population (Gaspé Peninsula in Québec)

1.2 Description

Crowded wormseed mustard is described as follows (Burzynski 2006):

“*Erysimum inconspicuum* var. *coarctatum* is a biennial or short-lived-perennial herb in the mustard family. It differs from var. *inconspicuum* by having greener and more crowded leaves, multiple stems (often), and richer yellow flowers with petals greater than 1 cm long (Scoggan 1979). Variety *coarctatum* grows up to 75 cm high on the Island of Newfoundland (pers. obs.). The basal leaves are oblanceolate and entire or nearly so; stem leaves are narrowly lanceolate or oblanceolate, entire, and obtuse to acute. The racemes of small yellow flowers are crowded into a corymb-like summit. Siliques (fruits) are broad, four-sided, and ash-coloured (Fernald 1950).”

Fernald (1950) gave its flowering period as June to August. In 1995, the Newfoundland plants were observed to be in flower on July 3rd and in fruit by August 5th (Burzynski 2006).

1.3 Populations and Distribution

There is only one known population in the Province of Newfoundland and Labrador, at Chimney Cove between the Bay of Islands and Gros Morne National Park on the western coast of the Island of Newfoundland. There were about 100 mature (flowering) plants at this site in 1995. In August 2000 no plants were seen, but this was thought to be due to the early withering of the plant after seed set (Burzynski 2006). There has been no survey since.

The plants are extremely difficult to count due to the clifftop location of the habitat. No count of immature rosettes was made as it was impossible to see them among the other vegetation.

1.4 Needs of Crowded wormseed mustard

1.4.1 Habitat and biological needs

Fernald (1950) describes the habitat of this plant as “Calcareous cliffs and gravels near Gulf of St. Lawrence” In Québec most of the plants are found on upper beaches composed of limestone gravel (Jacques Lebreque, pers. comm.). These beaches are essentially calcareous gravel flats above the high tide line.

At its Newfoundland location the substrate is thin soil at the edge of coastal cliffs composed of calcium-rich basalt, possibly resulting in a neutral to basic soil pH.

The vegetation community can be described as a meadow, with grasses, forbs and scattered shrubs. Companion species include *Shepherdia canadensis*, *Campanula rotundifolia*, and *Picea glauca* (all native) as well as the introduced species *Ranunculus*

acris, *Trifolium pratense*, *Hieracium* spp., *Athoxanthum odoratum*, *Phleum pratense* and *Leucanthemum vulgare*.

The plants were found close to the cliff edge, although it is not known to what extent this may be a habitat requirement. At this location, competition from grasses and other herbaceous plants (both native and introduced species) is perhaps reduced. While the degree of threat posed by grazing livestock has not been directly investigated, pressure from grazing may also be reduced. It is not known whether the plants could spread into the adjoining meadow if grazing pressure were relieved, or whether the competition from other plant species would preclude this.

1.4.2 Ecological Role

E. inconspicuum var. *coarctatum* is a biennial or short-lived-perennial. None of the plants examined at the Newfoundland location exhibited stems of previous years' flowers, and the short tap root and basal rosette of withered leaves seem to indicate a biennial lifestyle in which a rosette of leaves is formed in the first year (or years), then the plant flowers, sets seed, and dies. Long-term persistence of a colony of plants with this strategy is dependent upon the soil seed bank (Burzynski 2006).

In Newfoundland, Crowded wormseed mustard grows as a minor component of a meadow plant community, which is also the case in the Yukon Territory (Jennifer Line, pers. comm.) but on the calcareous upper beach flats in Québec the species is one of the dominant species in this sparsely vegetated ecosystem (Jacques Lebreque, pers. comm.).

Other ecological attributes have not been researched, and it is not known how many years the plants require before flowering.

1.4.3 Limiting Factors

It is possible that Crowded wormseed mustard occurs over an area greater than the known location. However, the coastal calcium-rich basalt outcrops that form the species' cliff edge habitat is limited in distribution to a stretch of coastline in western Newfoundland that is approximately 100 km long. Along this section of coastline, outcrops of basalt are interspersed with other rock types believed to be unsuitable for the species.

While Fernald (1950) characterized the habitat as "calcareous cliffs and gravels" suggesting a relatively broad niche, the plant has not been encountered during extensive searches of limestone barrens and limestone cliffs and talus slopes in western Newfoundland.

At the Newfoundland location, the rock is friable and unstable, and a large part of the cliff has a serious overhang. The instability of the habitat is probably the reason that this plant

has been able to survive, although with the entire known population growing in a 30 metre band along the edge of this cliff, a large rock failure could extirpate the plant.

It is not yet known to what extent livestock grazing and competition from other vascular plants, both native and exotic, could be limiting the species.

1.5 Threats

The only known Newfoundland population of Crowded wormseed mustard is located approximately 13 km from Trout River—the closest permanent settlement—and is not accessible by road. However, the site is boat and ATV accessible and the area is used for livestock grazing. Natural disasters, such as rock slides, also pose a threat to the species. Competition from exotic vascular plant species could also pose a threat.

As of 2008 there were six cabins at Chimney Cove. These cabins are located approximately 500 m from the Crowded wormseed mustard site and direct human presence at the site is not currently perceived to be a problem. An unapproved ATV trail has been constructed between Trout River and Chimney Cove. This improved access could make it more likely that the site is visited by ATV instead of by boat, and that perhaps cottage owners would be more likely to spend time in the area. A better trail will also be more inviting for casual day visitors who arrive and leave by ATV without spending the night in the area. During all site visits, surveyors will look for evidence of ATV operation or any other human use near the Crowded wormseed mustard population to determine whether ATV use or any other human activities near the plants have the potential to threaten the population.

Due to the low number of visits made to the site and the danger the site poses to surveyors, it is possible that other threats exist that have not yet been identified. These potential threats for which there is no current evidence are not included in the threat classification table.

1.5.1 Threat Classification Table

Table 1. Crowded wormseed mustard threat classification table.

Category of Threat	Threat General threat Specific threat	S-E Information Sector Activity Stakeholder	Causal Certainty		Timing	Frequency	Extent	Severity		Current Level of Concern
			Local	Range-wide				Local	Range-wide	
Exotic Species	Ge-livestock grazing Sp-removal of whole plants or flowers/seed capsules	Se-Animal production Ac-livestock grazing St-livestock owners	Medium	Medium	Current	Seasonal	Localized	Medium	Medium	Medium
Climate and natural disasters	Ge-Rockslides Sp-loss of individuals and habitat	Se-N/A Ac-Species management St-General public	High	High	Anticipated	Unknown, but believed to be Infrequent	Localized	High	High	Medium
Exotic Species	Ge-exotic plants Sp-competition limiting survival and reproduction	Se-Animal production Ac-introduction of forage plant species (possibly inadvertently)	Low	Low	Current	Constant	Localized	Medium	Medium	Low

1.5.2 Description of Threats

Exotic Species

Burzynski (2006) summarized the threat by exotic species as follows:

“An open meadow adjoins the top of the cliff. Although this meadow is extremely steep, it is used by grazing cows, horses, and sheep that are summered at Chimney Cove by residents of Trout River and other coastal communities. The tracks and droppings of these animals are found right up to the edge of the cliff, and with some regularity animals fall off this headland as they reach for plants to eat. Grazing is probably a serious threat since there are so few of these plants. Since grazers could remove developing seed capsules several years in a row, and if this plant is biennial that could have drastic consequences for the survival of *E. inconspicuum* on the island.”

At the time of writing, direct damage to Crowded wormseed mustard plants by grazing animals has not been documented, and therefore this should be considered a potential threat until research confirms a detrimental effect of animal grazing.

It appears that the grazing in Chimney Cove is not deliberate, but that the animals escape from the Trout River community pasture due to broken fences. The grazing of livestock is not regulated by the Agrifoods Branch of the Newfoundland and Labrador Department of Natural Resources, although they are aware of the grazing at this site. It is not known how many individuals graze livestock in the area and preliminary information indicates that there are approximately 30 cattle and 15 horses at Chimney Cove during the summer. Depending on economic and other factors, the number of livestock and livestock owners probably varies from year to year.

Through settlement and introduction of domestic grazing animals, exotic plant species were also introduced. It is unlikely that this introduction was deliberate, but that the species were introduced in animal droppings or hay. It is not known to what extent competition from these species has a detrimental effect on the Crowded wormseed mustard population, but the plants seem to be absent in areas with dense herbaceous vegetation. It is also unknown how the competition by exotic species compares to competition by native species.

Climate and natural disasters

The Crowded wormseed mustard plants all grow along the upper edge of a 150 metre-high basalt cliff at the ocean's edge. The rock is friable, and a large part of the cliff has a serious overhang. The instability of the habitat is probably the reason that this plant has been able to survive, although with the entire known population growing in a 30 metre band along the edge of this cliff, a large rock failure could extirpate the plant (Burzynski 2006).

Small rock slides that would destroy only a part of the population are a likelier threat.

1.6 Actions Already Completed or Underway

As none of the threats have been considered to be of a high level of concern, and due to the difficulty of visiting the known site and potential habitat areas, no recovery actions have yet been initiated.

1.7 Knowledge Gaps

Currently most aspects of the species' biology in Newfoundland are unknown. To initiate and facilitate recovery actions, it would be necessary to determine the following:

- Population size
- Distribution in Newfoundland
- Population dynamics (i.e. are there large population fluctuations?)
- Rate of reproduction
- Characteristics of the seedbank
- Seed dispersal distances
- Effects of herbivores and pathogens
- Genetic relationship to other populations
- Threats currently affecting the population

2. RECOVERY

2.1 Recovery Feasibility

The primary limiting factor in the recovery or expansion of the species is habitat specificity. Habitat specificity of Crowded wormseed mustard dictates that it is likely to always remain rare within the province. Recovery and the prevention of any further population decline are possible provided that existing grazing pressure is managed and mitigated from the known site. Currently, Crowded wormseed mustard appears to have sufficient habitat and seed production to have persisted at the current known site since its first discovery there in 1895. Even though the plant was not seen during the last site visit in August 2000, it is highly likely that the plant species is still present..

If the species is truly restricted to one small Newfoundland site it would always be at risk of being affected by a single catastrophic event, such as a rock slide. An *ex situ* population could serve to re-populate the area in the case of such a disaster. Also, it is possible that there is enough suitable habitat where additional populations exist or could be established. With several populations the feasibility of maintaining the species on the landscape would depend less on *ex situ* efforts and the probability of stochastic events.

2.2 Recovery Goal

The primary goal of this recovery plan is to secure the long-term persistence of the Endangered Crowded wormseed mustard in the Province of Newfoundland and Labrador in its current location, as well as in more than one population, which may have to be introduced.

2.3 Population and Distribution Objectives

The specific population and distribution objectives for Crowded wormseed mustard are:

1. to maintain the population size as constant as possible ; and
2. to maintain populations at viable levels in at least two Newfoundland locations.

2.4 Recovery Objectives

The specific recovery objectives for Crowded wormseed mustard are:

1. to determine the population size, distribution, reproductive biology, and ecology of the species to facilitate other recovery actions;
2. to clarify the concern posed by existing threats and to determine if there are other as yet unidentified threats;
3. to further identify land uses and work with land users to develop acceptable mitigations;
4. to prevent any population declines and extirpations resulting from controllable factors, such as grazing pressure and ATV use;
5. to establish an *ex situ* population large enough to reintroduce the species if it should become extirpated from its natural habitat in Newfoundland;
6. to ensure that there are at least two known sites in Newfoundland with a viable population, using introduction of the species outside its known range if necessary.

2.5 Approaches Recommended to Meet Recovery Objectives

2.5.1 Recovery Planning

Table 3. Summary of specific recovery actions needed to meet recovery objectives and mitigate threats.

Broad Strategy to Address Threats	Threat(s)	Priority	Recovery Objective	Specific Recovery Actions
Population Inventory and Monitoring				
Search for Additional Populations and Suitable Habitat		urgent	1	<ul style="list-style-type: none"> Identify all areas of potential habitat in western Newfoundland that are similar to the habitat of the known population Survey as many of the identified habitat areas as possible
Population Counts		urgent	1	<ul style="list-style-type: none"> Count the number of individuals present, both immature and flowering, on a regular basis
Monitoring	all	urgent	1	<ul style="list-style-type: none"> Monitor survival and reproduction of a subset of the plants at all known locations (natural and introduced) for five years in a row, then every 2 years thereafter.
Scientific Research				
Ecology	3	necessary		<ul style="list-style-type: none"> Describe the soil type and physical habitat variables Conduct experiments to determine whether competition could be negatively affecting the population
Reproduction		necessary	1, 5	<ul style="list-style-type: none"> Determine seed set variability Determine seed dispersal distances
Seed Bank		necessary	1, 5	<ul style="list-style-type: none"> Determine whether there is a viable seed bank present Determine what proportion of the seeds are viable, and how the viability decreases with age Determine which conditions are required for seed germination
Herbivory and Pathology	1	necessary	1, 2	<ul style="list-style-type: none"> Examine plants for evidence of damage from livestock grazing or trampling Examine the plants for damage from insect pests and/or bacterial/viral pathogens
Genetics		beneficial		<ul style="list-style-type: none"> Determine whether the plants in the NL population are different from plants of the QC population of the same variety Determine whether the variety <i>coarctatum</i> is distinct from the typical variety
<i>Ex Situ</i> Conservation				

Broad Strategy to Address Threats	Threat(s)	Priority	Recovery Objective	Specific Recovery Actions
Seed Bank or Live Collection	all	urgent	5, 6	<ul style="list-style-type: none"> Determine through research whether seed banking or a live collection would be a more appropriate <i>ex situ</i> conservation method Collect seed Either freeze seeds in an established seed bank, or plant the seeds to establish and maintain a <i>ex situ</i> collection of live plants
Population Introduction				
Population Introduction	all	beneficial	6	<ul style="list-style-type: none"> If no additional populations are located, determine whether enough seeds can be collected from the known population and propagated to establish one or more introduced populations If it is feasible, develop criteria for site selection, select sites and conduct establishment experiments Establish one or more artificially seeded populations in the wild in suitable habitat Determine through research the parameters where the population would be considered self-sustaining Supplement the introduced populations with seeds until they are self-sustaining
Population and Habitat Management				
Interim Habitat Protection		urgent	4	<ul style="list-style-type: none"> Identify and mitigate for resource conflicts Designate the known population area and immediate surroundings as a Sensitive Wildlife Area
Livestock Exlosures	1, 3	necessary	3, 4	<ul style="list-style-type: none"> Construct a fence to exclude livestock in consultation with the land users
Critical Habitat Assessment and Protection	1, 3	necessary	3, 4	<ul style="list-style-type: none"> Delineate the area currently known to be occupied Identify and evaluate areas of potentially suitable habitat After extensive surveys, identify and map critical habitat Choose one or more sites for introduction and delineate these Develop and implement protection mechanisms, such as critical habitat regulations
Education and Stewardship				
Consultations with Site Users	1,3	necessary	3, 4	<ul style="list-style-type: none"> Meet with individual users of the area, such as cottage owners and individuals grazing livestock in the area to inform them of the species, the threats, the Endangered Species Act and any planned recovery actions Engage land users in the recovery of the species
Information Dissemination to COs	1, 3	necessary	4	<ul style="list-style-type: none"> Inform COs of the species, the location of the natural (and introduced) locations, recovery actions taken and any role that they may play in enforcement of the <i>Endangered Species Act</i>

2.5.2 Narrative to support Recovery Planning Table

Six general approaches have been pursued to meet the recovery goals and objectives for Crowded wormseed mustard: population inventory and monitoring; scientific research; *ex situ* conservation; reintroduction; population and habitat management; and education and stewardship.

Population inventory and monitoring

Search for additional populations and suitable habitat

As the species currently seems confined to an open coastal environment underlain by calcium-rich basalt, searches for additional populations will initially be restricted to the same type of habitat. Along the approximately 100 km of coastline in western Newfoundland where basalt is found, aerial photographs will be examined to determine which areas to visit.

All potential habitat areas that are safe will be visited by boat or helicopter, and a search for Crowded wormseed mustard will be conducted. More detail is given in section 2.6.3. If in the future additional populations are found in very different types of habitat, other areas with this other habitat will also be searched.

Population counts

Efforts will be made to count as many individuals as can be safely done. Ideally, individuals of all ages (rosettes and flowering plants) will be counted.

Monitoring

All populations of Crowded wormseed mustard found, as well as any that will be artificially established, will be monitored as well as possible without endangering the observers. Initially, monitoring should be done for at least five years in a row to determine whether there are serious year-to-year population fluctuations due to the species' biennial life cycle. Tagging of individual plants of each life stage will allow the determination of the duration of the rosette stage.

Scientific research

Crowded wormseed mustard lives in a dynamic habitat characterized by an unstable substrate and an open environment adjoined by a coastal meadow.

Ecology

To obtain a better understanding of the site requirements and ecological niche of the species, the soil at the Chimney Cove site will be examined and parameters including depth, organic matter content and pH will be determined.

If possible, habitats outside of the province will also be investigated. This, combined with a thorough analysis of the plant's habitat in Newfoundland, would help to evaluate

sites that currently do not support Crowded wormseed mustard as to their suitability for the establishment of an introduced population.

It is possible that competition from other vegetation is (or could become) a threat. The vegetation at the site will be described in more detail and will be monitored for any expansion or increase in coverage, or density. During the next visit to the population site it will be determined whether trials involving the removal of patches of the existing vegetation can be conducted without negatively impacting the existing population.

If competition is found to be a threat, control of competition will be considered.

Reproduction

An understanding of the rate of seed productivity is essential for determination of how many seeds can be collected for research, *ex situ* storage and reintroduction without negatively affecting the population. Alternatively, additional seed could be produced through the cultivation of *ex situ* plants.

Seed bank

The role of the seed bank will be determined by examining the number of seeds present, their viability period, and the conditions that facilitate germination.

Herbivory/pathogens

The level and extent of herbivory by livestock will be investigated to determine if this poses a threat to the population. Plants will also be examined for damage by insect pests and bacterial, viral, or fungal pathogens.

Genetics

Fernald (1950) believed the variety *coarctatum* to be a Gulf of St. Lawrence endemic, and considered all other *Erysimum inconspicuum* populations to belong to var. *inconspicuum*. However, G.A. Mulligan, a Canadian Brassicaceae expert, examined specimens from the continental Northwest Territories, Alberta, British Columbia and the Yukon Territory and revised them to var. *coarctatum* as well (Cody *et al.* 2000). Except for the Yukon Territory, these revisions are not reflected in NatureServe Explorer website, and it is unknown as to whether this is due to the other jurisdictions not being aware of these revisions or not accepting the revisions.

Genetics studies could clarify whether the Newfoundland population is unique or whether it is genetically similar to populations occurring in Québec, and whether the Gulf of St. Lawrence populations (Newfoundland and Québec) differ from those in more western areas of northern Canada. During these studies it could also be determined whether this geographically restricted variety differs enough from the typical subspecies to warrant recognition.

***Ex situ* conservation**

Either a seed bank or a live *ex situ* population will be maintained as a failsafe, in the

event of an extinction. Reintroduction will be considered in the case of a major population reduction due to catastrophic events if sufficient habitat is available. Studies will be conducted to determine whether seed banking or live collection is the more appropriate method of *ex situ* conservation, as it is unlikely that enough resources will be available to do both.

If seed banking is the chosen method, representative genetic stock of seeds from all known Crowded wormseed mustard populations will be preserved at the Memorial University Botanical Garden and the National Seed Bank. If a live collection is more appropriate, an *ex situ* population of living Crowded wormseed mustard individuals from all populations will be established at the Memorial University Botanical Garden. At the moment, requirements and protocols for seed collection and germination are not available; they will be developed by the Memorial University Botanical Garden.

Population introduction

In case no other populations are located in Newfoundland, at least one additional population will be established in suitable habitat. This will be first done on a trial basis to determine the feasibility and to develop protocols for the initiation and maintenance of new populations. The possibility of introducing a population in Gros Morne National Park will be investigated. Criteria to determine site suitability will be developed in further recovery team meetings.

Any newly established populations will be closely monitored to determine when they can be self-sustaining. Until this point is reached, the introduced population may have to be periodically augmented with seed or transplants from the *ex situ* collection. Research will determine whether seeds or transplants will result in higher survival prior to any attempt at population introduction.

Population and habitat management

Livestock exclosures

A fence in the upper portion of the meadow near the cliff face could prevent domestic livestock from consuming or trampling Crowded wormseed mustard plants or causing soil erosion.

Local land users will be consulted before any construction. It is estimated that less than 50 m of fence would be necessary.

The fence will be considered experimental. In order to avoid affecting the Crowded wormseed mustard population during construction, it will not bisect the main part of the population. It will be assessed on site whether a control population outside of the fence is possible. If the reduced grazing inside the fence results in increased competition from surrounding vegetation, this could be a greater threat to Crowded wormseed mustard than the grazing pressure. If this is found to occur, the fence will be removed.

The location of the fence will have to be carefully considered. A site assessment will be performed to determine the most appropriate type of fence and location, as well as possible anchoring methods. The fence will be designed to avoid habitat alterations such as changes in snow accumulation, shading and air movement.

As the fence is likely to draw attention to the area, signs outlining the species and its protection under the *Endangered Species Act* will be posted at the fence.

Critical habitat assessment and protection

The process for determining critical habitat for Crowded wormseed mustard has not yet been initiated. The process will involve delineating known population areas and determining the species' habitat requirements. If the one currently known population remains the only population known from the province, at least one other suitable habitat area will be identified as critical habitat for population introduction. Once critical habitat is identified, protection measures will be recommended and implemented.

Interim habitat protection

In the interim, designation of the known population location as a Sensitive Wildlife Area will be investigated. This type of protection will also be extended to other suitable habitat areas that are likely candidates for introduction of the species. This designation would ensure that the Wildlife Division will receive and be able to review all development applications (such as applications for additional cottages in the area).

Education and stewardship

Consultations with site users

Recommendations will be sought from Trout River residents as to how to best identify and approach the individuals that have cabins near the Crowded wormseed mustard population or that use the area for livestock grazing and/or day visits. The site users will be made aware of the species, the laws regarding its listing as "Endangered", and the fencing project. Their input on possible recovery actions will be sought. If they are interested they could participate in informal monitoring of the area, such as reporting rock slides.

Information dissemination to Conservation Officers

Conservation Officers (COs) are responsible for the enforcement of the *Endangered Species Act* and the COs of District 15 will be made aware of the species, the location of the known population, and any other locations that may be found or established in the future. COs will also be made aware of any recovery actions taken and will be briefed on the role they may play in stewardship and the enforcement of the *Endangered Species Act*.

2.6 Performance Measures

Table 4: Performance measures to evaluate recovery approaches and methods.

Recovery Objective	Performance Measures	Date
1. to determine the population size, distribution, reproductive biology and ecology	• A map and air photo search for potentially suitable sites has been completed	Dec. 2008
	• The potentially suitable habitat areas have been ground surveyed for habitat suitability and presence of Crowded wormseed mustard (CWM)	Aug. 2009
	• The habitat of the currently known CWM has been better described	Aug. 2009
	• The known population of CWM has been counted	Aug. 2009
	• The population demographics and dynamics, as well as seed production of CWM have been investigated by three years of monitoring	Aug. 2011
	• The presence and viability of a seed bank have been determined	Sept. 2009
2. to clarify the concern posed by existing threats and to determine if there are other threats	• A site visit has been conducted to determine the presence and severity of herbivory and/or any other agent or activity that has the potential to harm CWM individuals or the habitat	Aug. 2009
	• CWM plants have been examined for evidence of pests and pathogens, and if any have been observed, they have been identified	Nov. 2009
3. to further identify land uses and develop acceptable mitigations	<ul style="list-style-type: none"> • A site visit has been conducted to determine the presence of any previously known land uses • If land uses that may require mitigations were identified, land users have been consulted 	Aug. 2009 Dec. 2009
4. to prevent any population declines and extirpations resulting from controllable factors	• The feasibility of a livestock enclosure has been assessed	Aug. 2009
	• If feasible, an experimental enclosure has been constructed and signed	Oct. 2010
	• If an enclosure was constructed it has been evaluated for positive and negative effects	Aug. 2012
	• Known site declared a Sensitive Wildlife Area for interim protection	May 2009
	• Critical Habitat identified and protected with regulations if necessary	May 2011
5. to establish an <i>ex situ</i> population	• Seeds have been collected and deposited in seed banks at least 2 different institutions	Sept. 2009
	• Seed viability declines over time have been examined	July 2014
	• A live collection has been established at the MUN Botanical Garden	Sept. 2010
	• The <i>ex situ</i> collection has been maintained in the long term	March 2014
6. to ensure that there are at least two sites in NL	Either another wild population has been discovered or	Aug. 2009
	• At least three potential introduction sites with suitable habitat have been identified	Aug. 2009
	• Establishment experiments have been conducted and experimental populations monitored	Sept. 2011
	• If introduction is feasible, at least one additional population has been established	Sept. 2013

2.7 Critical Habitat

2.7.1 Identification of the species' critical habitat

It is not anticipated that the species will ever be abundant enough in Newfoundland to be no longer at risk; therefore all of the habitat to be identified and protected will be critical habitat, rather than recovery habitat.

The identification of critical habitat for Crowded wormseed mustard has several components:

1. Delineating the area of the known population, and other populations as they are discovered;
2. Determining the habitat requirements; and
3. Identifying any other areas of suitable habitat where the species could exist and could be seeded or transplanted to in case of extinction at the known location.

2.7.2 Examples of activities likely to result in destruction of critical habitat

Destruction of critical habitat is most likely due to natural disasters, such as rock slides. In this case the whole known habitat area could be destroyed in a single catastrophic event.

Another possibility would be that increased ATV traffic in the adjoining meadow could lead to site degradation by soil erosion and/or compaction. Trampling by livestock could also result in soil erosion and compaction.

Due to the location of the known population on the overhang of a high cliff, human traffic and activities will probably remain minimal.

2.7.3 Schedule of studies to identify critical habitat

Critical habitat has not yet been delineated, but the location of the known population will be considered critical habitat. A search for additional populations and additional suitable sites to designate as critical habitat will be conducted as follows:

1. Identify areas of similar geology as the currently known population in western Newfoundland;
2. Use air photos to identify open habitat in areas of suitable geology; and
3. Visit sites identified by the above methodology to determine whether they are inhabited by Crowded wormseed mustard, and if not, whether the habitat is suitable.

If no additional populations are located, one of the suitable habitat areas will be chosen as recovery habitat. The site chosen will be one that is expected to remain as undisturbed by human activities as possible in the foreseeable future. If several such sites exist, the most accessible one will be chosen.

2.8 Existing and Recommended Approaches to Habitat Protection

If onsite visits show this to be feasible, critical habitat protection will involve the exclusion of livestock grazing and ATV use by fencing. The fence will be considered experimental in the sense that if it does not enhance the survival and reproduction of the species or if it constitutes a threat in itself by increasing competition, it will be removed.

2.9 Effects on Other Species

Crowded wormseed mustard is restricted to a narrow strip of meadow at the edge of coastal cliffs in western Newfoundland. None of the associated species are rare in Newfoundland and any control of livestock or other protection measures applied to Crowded wormseed mustard are unlikely to affect the populations of other species to any appreciable extent. Effects of the enclosure on the livestock are anticipated to be positive, as the fence would prevent the animals from falling over the cliff in the population area.

2.10 Recommended Approach for Recovery Implementation

The Crowded wormseed mustard occupies a small area in a very isolated location. Due to the absence of other listed species in the area, or even from similar habitat in different areas, the species is not amenable to inclusion in any ecosystem level recovery efforts designed to benefit a suite of species.

None of the threats to the species are of such a high concern that they need to be addressed before all else. One of the first priorities will be a site visit, and due to the remoteness of the site, every visit will serve multiple purposes. During the first site visit the following actions will be taken: a count of the population, establishment of a monitoring protocol, assessment of the feasibility of the construction of a livestock enclosure, further assessment of the threats to the population, collection of information about the species' biology and ecological requirements and collection of seeds for *ex situ* conservation.

Visits to sites with similar habitat where Crowded wormseed mustard could exist, or could be seeded or transplanted to, will also be of a high priority. The information collected from this survey, as well as the initial site visit will be used to further prioritize the remaining recovery actions.

Interim protection of the site will be sought through designation as a Sensitive Wildlife Area. This type of protection will also be extended to any other Crowded wormseed mustard sites that might be discovered.

It is unlikely that enforcement of the prohibitions against destroying/harming the plants will form a large component of the protection of the species due to the difficulty of patrolling the area and the low likelihood that either accidental or deliberate destruction of the plants will become an issue.

3. REFERENCES

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4. RECOVERY TEAM MEMBERS

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